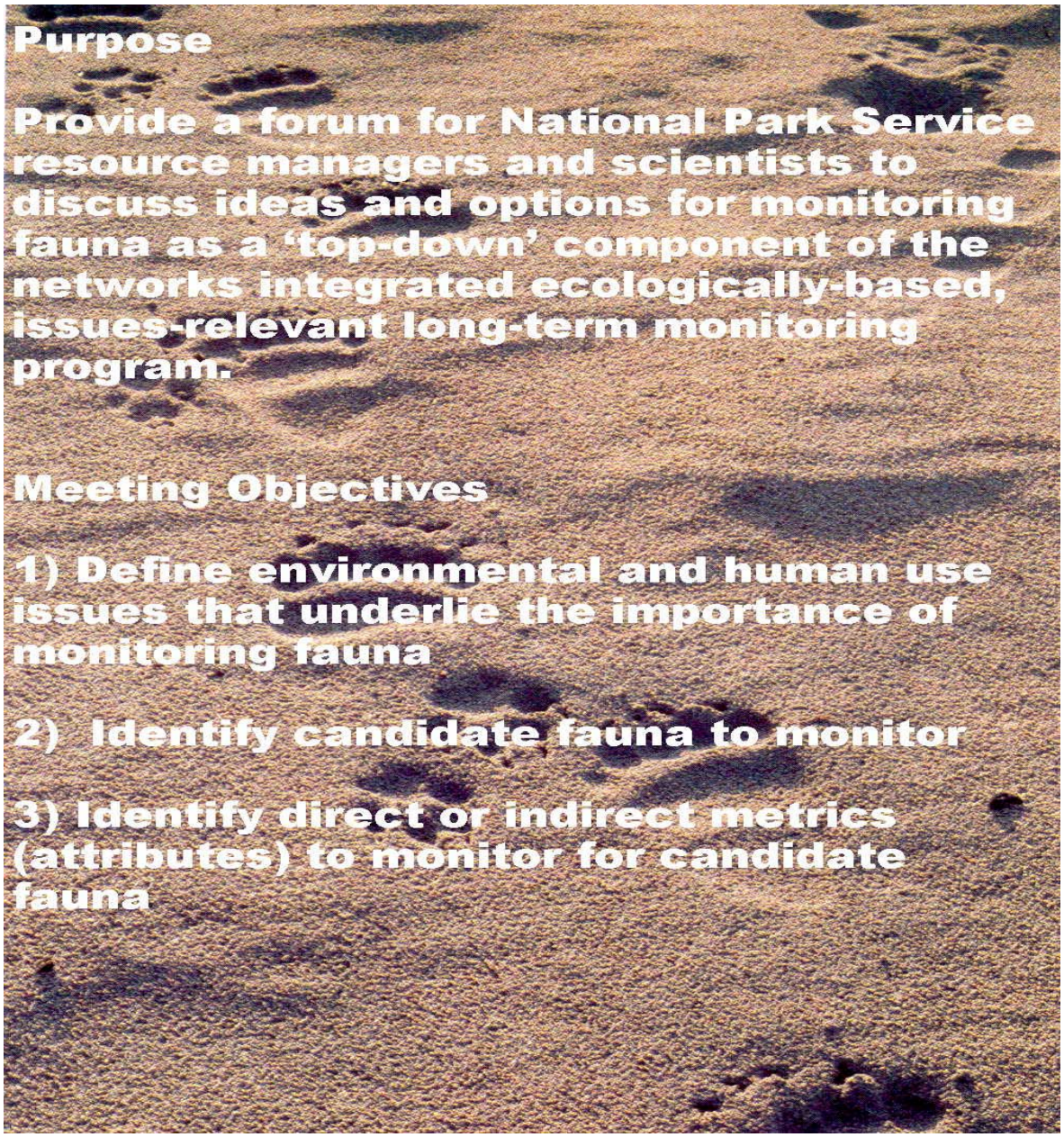
National Park Service - Southwest Alaska Network
Inventory & Monitoring Program

Fauna Monitoring – Scoping Meeting
Vital Signs Monitoring Program
Southwest Alaska Network
17 April, 2003



Background Material Contained in this Document

Section **Page**

DRAFT AGENDA
Fauna Monitoring Scoping Meeting
Southwest Alaska Network
BLM-Campbell Creek Science Center
April 17, 2003, 8:00 AM – 4:30 PM

8:00-8:20 AM	Participant Introductions. Overview of the networks goals for long-term monitoring, review of earlier workshops, and expectations of this fauna scoping meeting. Alan Bennett, Network Coordinator
8:20-8:45 AM	Introduction to Network Parks, highlighting key fauna resources, interactions, and fauna-habitat relationships. Ian Martin- Kenai Fjords.
8:45-9:00 AM	Introduction to the conceptual models and approaches for choosing fauna to monitor. Karen Oakley USGS-Alaska Science Center
9:00–10:00 AM	**Session 1**. Review and discussion of fauna resource monitoring relative to conceptual ecosystem models and the 5 roles of 'landscape species.' What are the most important resource protection issues and scientific issues, or manifestations of those issues, that we need to consider in selecting fauna to monitor?
10:00 AM	Break
10:15–12:00 AM	**Session 2**. Identification of a suite of candidate fauna to monitor based on network objectives, models, and the 'landscape species principle.'
12:00-1:15 PM	Lunch
1:15–2:00 PM	**Session 2**. continued
2:00–3:15 PM	**Session 3**. Identify direct or indirect metrics (attributes) to monitor for candidate fauna
3:15 PM	Break
3:30–4:30 PM	Closing remarks. Each guest participant (those highlighted on the attendees list) will have up to 15 minutes to comment on scoping meeting discussions, offer their agencies perspective on our goals and approach to monitoring, identify issues we may have overlooked, or offer specific recommendations concerning the design of this monitoring program.
4:30	Adjourn

2. Rationale For Long-term Monitoring In Southwest Alaska National Park Units And The Role Of This Meeting

National Park Service Inventory and Monitoring Program- After completing a review of the natural resources management program of the National Park Service (NPS) in 1992, the National Academy of Sciences stated that if the NPS is to meet the scientific and resource management challenges of the twenty-first century, a fundamental metamorphosis must occur. That metamorphosis materialized when NPS implemented a strategy to standardize natural resource inventory and monitoring on a programmatic basis throughout the agency. The effort was undertaken to ensure that the approximately 270 park units with significant natural resources possess the resource information needed for effective, science-based managerial decision-making and resource protection. The national strategy consists of a framework having three major components:

(1) completion of basic natural resource inventories in support of future monitoring efforts;
(2) creation of experimental Prototype Monitoring Programs to evaluate alternative monitoring designs and strategies; and
(3) implementation of operational monitoring of selected parameters (i.e. "vital signs") in all natural resource parks.

Knowing the condition of natural resources in national parks is fundamental to the Service's ability to protect and manage parks. National Park managers across the country are confronted with increasingly complex and challenging issues, and managers are increasingly being asked to provide scientifically credible data to defend management actions. Many of the threats to park resources, such as invasive species and air and water pollution, come from outside of the park boundaries, requiring an ecosystem approach to understand and manage the park's natural resources.

A long-term ecosystem monitoring program is necessary to make better informed management decisions, to provide early warning of abnormal conditions in time to develop effective mitigation measures, to convince other agencies and individuals to make decisions benefiting parks, to satisfy certain legal mandates, and to provide reference data for relatively pristine sites for comparison with data collected outside of parks by other agencies. The overall purpose of monitoring is to develop broadly based, scientifically sound information on the current status and long term trends in the composition, structure, and function of the park ecosystem. Use of monitoring information will increase confidence in manager's decisions and improve their ability to manage park resources.

National Park Service policy and recent legislation (National Parks Omnibus Management Act of 1998) requires that park managers know the condition of natural resources under their stewardship and monitor long-term trends in those resources in order to fulfill the NPS mission of conserving parks unimpaired. The following laws and

management policies provide the mandate for inventorying and monitoring in national parks:

The mission of the National Park Service is:
"*...to promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purposes of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations*" (National Park Service Organic Act, 1916).

"*The Secretary shall undertake a program of inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the condition of National Park System resources. The monitoring program shall be developed in cooperation with other Federal monitoring and information collection efforts to ensure a cost-effective approach*" (National Parks Omnibus Management Act of 1998)

"*Natural systems in the national park system, and the human influences upon them, will be monitored to detect change. The Service will use the results of monitoring and research to understand the detected change and to develop appropriate management actions*" (2001 NPS Management Policies).

Southwest Alaska Network- In Alaska, national park units have been assigned to 4 inventory and monitoring networks. The networks were based on ecological similarity and physical proximity. The southwest Alaska network consists of 5 units:

(1) Alagnak Wild River (ALAG),
(2) Aniakchak National Monument and Preserve (ANIA),
(3) Kenai Fjords National Park (KEFJ),
(4) Katmai National Park and Preserve (KATM), and
(5) Lake Clark National Park and Preserve (LACL).

The timeline for designing the Southwest Alaska Network monitoring program and writing a monitoring plan is approximately 5 years. Natural resources staff from each of the parks and staff from the NPS Alaska Support Office jointly form a core planning team, known as the *Technical Committee* (TC). This committee is chaired by the Network Coordinator and reports to the Park Superintendents and Regional I&M Coordinator.

The Southwest Alaska Network began operations in 2000 with the planning of biological inventories for vascular plants, freshwater fish, and small mammals. The target objective of biological inventories is to document the occurrence of 90% of the expected species in network parks. Baseline knowledge is weak for SWAN parks, and these inventories represent the first systematic efforts to document species occurrence for

these taxa in these parks. Biological inventories will occur over four years with data analysis and final reports scheduled for 2005.

Scoping Workshops- Planning for long-term "vital signs" monitoring began in January 2002. The planning process is built around a series of mini-scoping workshops and meetings where the Technical Committee and scientists from other agencies collaborate in reviewing our current state of knowledge, identifying factors affecting park ecosystems, and identifying candidate attributes to monitor. This scoping meeting is the fourth in a series of such meetings and workshops held between August 2002 and May 2003.

Scoping meetings for coastal and freshwater resources were held in August and November 2002. The meeting formats proved highly successful in generating useful discussion about Southwest Alaska Network park ecosystems and monitoring strategies. A summary document is compiled for each workshop and circulated for review among the participants. These summaries provide a record of discussion and will be used by the Technical Committee to make decisions concerning the selection of "vital signs" or sampling design for monitoring. We hope to build on that process with this fauna session and successive workshops.

In planning for long-term monitoring, it is useful to have some idea of the financial and logistic constraints. The ambitious nature of the NPS monitoring program and its relatively limited budget make careful design of the program critical. Effort must be strategically directed toward areas that give the most return of useful information for time and money invested.

Beginning in 2004, the total projected annual operating budget for the SWAN monitoring program will be 1.4 million dollars. All program costs including administration and salaries, data management, and operational monitoring must be supported by this budget. Core permanent employees of each network may include the Coordinator, Biometrician, and Data Manager. Hence, it is reasonable to assume that the operating budget for this network will be roughly 1.0 million dollars.

Timeline for the Southwest Alaska Network to complete the entire planning and design process for developing a monitoring plan.

	2001 Oct-Dec	2002 Jan-Jul	2002 Aug-Dec	2003 Jan-Jul	2003 Aug-Dec	2004 Jan-Jul	2004 Aug-Dec	2005 Jan-Jul	2005 Aug-Dec
Data gathering, internal scoping									
Inventories to Support Monitoring									
Scoping Workshops									
Conceptual Modeling									
Indicator Prioritization and Selection									
Protocol Development, Monitoring Design									

3. Mandates Underlying the Need for Long-term Monitoring and Goals for Vegetation Monitoring

NPS Mandate:- " . .to preserve for the benefit, use, and inspiration of present and future generations . . ". .

SWAN Park and Preserve Mandates

Katmai National Park and Preserve- "for the protection of the ecological and other scientific values of Naknek lake and the existing monument….." "To protect habitats for, and populations of, fish and wildlife, including, but not limited to, high concentrations of brown/grizzly bears and their denning areas; to maintain unimpaired the water habitat for significant salmon populations; and to protect scenic, geological, cultural, and recreational features."

Alagnak National Wild River- "To protect and enhance the values which caused it to be included in said system…." These values are the river's outstandingly remarkable scenic, fish and wildlife, and recreation attributes. (ANILCA)

Aniakchak National Monument and Preserve- "To maintain the caldera and its associated volcanic features and landscape, including the Aniakchak River and other lakes and streams, in their natural state; To protect habitat for, and populations of, fish and wildlife, including, but not limited to, brown/grizzly bears, moose, caribou, sea lions, seals, and other marine mammals, geese, swans, and other waterfowl….." (ANILCA)

Lake Clark National Park and Preserve- "To protect the watershed necessary for the perpetuation of the red salmon fishery in Bristol Bay; To maintain unimpaired the scenic beauty and quality of portions of the Alaska Range and the Aleutian Range, including volcanoes, glaciers, wild rivers, lakes, waterfalls, and alpine meadows in their natural state; To protect habitats for and populations of fish and wildlife, including, but not limited to caribou, Dall sheep, brown/grizzly bears, bald eagles, and peregrine falcons." (ANILCA)

Kenai Fjords National Park- "To maintain unimpaired the scenic and environmental integrity of the Harding Icefield, its outflowing glaciers, and coastal fjords and islands in their natural state; and to protect seals, sea lions, other marine mammals, and marine and other birds and to maintain their hauling and breeding areas in their natural state, free of human activity which is disruptive to their natural processes." (ANILCA)

Protect and Manage Natural Resources

Maintain landscape features, ecosystems, communities, populations, trophic structure, and productivity within the historic bounds of natural variability

Understand Natural Resources and Ecosystem Dynamics

Conduct Resource Inventories

Conduct Long-term Monitoring

NPS Service-wide Vital Signs Monitoring Goals

1. Determine status and trends in selected indicators of the condition of park ecosystems to allow managers to make better-informed decisions and to work more effectively with other agencies and individuals for the benefit of park resources.

2. Provide early warning of abnormal conditions of selected resources to help develop effective mitigation measures and reduce costs of management.

3. Provide data to better understand the dynamic nature and condition of park ecosystems and to provide reference points for comparisons with other, altered environments.

4. Provide data to meet certain legal and congressional mandates related to natural resource protection and visitor enjoyment.

5. Provide a means of measuring progress towards performance goals

Fauna Monitoring Objectives, Southwest Alaska Network:

1. Observe and understand natural variability in the occurrence and distribution of terrestrial fauna species and communities across the landscape.

2. Understand how ecologically pivotal species are changing over time and, when possible, the functional consequences of this change on other animals, plants, communities, and ecosystems.

3. Document and understand how demographic patterns of animal populations are responding to environmental factors and human effects across spatial and temporal scales.

4. Understand how faunal distribution and vegetation patterns are related to each other, and predict how changes in vegetation affect fauna.

4. Conceptual Foundation for Monitoring

Clearly, the Southwest Alaska Network embodies a vast, diverse, and complex landscape. Monitoring at large geographic scales requires an understanding of relationships between components and processes of interacting ecosystems and the human activities that affect them. The network has defined a draft conceptual foundation to serve as a guide for monitoring.

> *"The Southwest Alaska Network and its surrounding landmass, freshwater systems, and coastlines are an interconnected set of ecosystems that must be monitored as an integrated whole. Within this interconnected whole, at time-scales of years to decades, we assert that climate, natural disturbance, biotic interactions, and human activities are the most important driving forces in determining ecosystem structure and function. Consequently, our monitoring program must address the interplay of multiple forces, which occur at a variety of spatial and temporal scales, in order to understand the landscape and changes in structure and function."*

This conceptual foundation is basis for a program that will be:

- **Ecologically-based** and **issues-oriented** with emphasis on assessing long-term and cumulative effects rather than short-term and isolated effects

- **Interdisciplinary** and incorporates disciplines of biology, hydrology, geomorphology, and landscape ecology and at multiple scales (e.g., coarser-grained network-scale, and finer-grained park-scale).

- **Integrative** and blends "top-down" approach for characterizing ecological systems, with "bottom-up" understanding of ecosystem processes and functions

To achieve success and continued support, this monitoring program must provide data that are both useful and widely used. The data must be relevant to topics of widespread interest as well as those of specific management concern. Most importantly, the information generated from the monitoring program is intended to assist the park manager in clarifying and addressing issues as part of the decision-making process.

As used in this document, "issues-oriented monitoring" implies that some park resources by virtue of legislative mandate, importance to stakeholders, or risk from a specific threat may receive attention beyond that which would emerge from their ecological position of importance in the landscape. It *does not* imply that monitoring is "issue-driven" and will focus only on a narrow range of issues perceived to be relevant to today's management challenges. The network's monitoring program simply cannot address every resource management interest. Limitations exist because institutional resources devoted to monitoring practices are often constrained by time, finances, and personnel.

The intent of this program is to monitor a select set of ecosystem processes and components that reflect the status of network ecosystems and are relevant to management issues. This information will collectively provide a foundation for understanding the parks and building a more flexible monitoring program. As monitoring proceeds, as data sets are interpreted, as our understanding of ecological processes is enhanced, and as trends are detected, future issues will emerge.

5. Landscape Species Principle

The Landscape Species Principle developed by the Wildlife Conservation Society (WCS 2002) may be a useful backdrop for discussions during sessions 1&2 of the scoping meeting. 'Landscape species' use large, ecologically diverse areas and have significant impacts on the structure and function of natural ecosystems (WCS 2002). Their habitat requirements in time and space make them particularly vulnerable to the land use and resource harvesting practices of humans. Meeting the habitat needs of, and removing threats to, landscape species builds a strong foundation to conserve the biodiversity and ecological integrity of the world's great wildlands. To be characterized as a landscape species, a wildlife species must serve one or more of the following roles:

a) Ecological function role

Some species or groups of species play a disproportionate role in the ecosystem by –

- Transferring matter or energy
- Structuring the environment
- Creating opportunities for other species
- Or regulating other species

The movements of these ecologically pivotal species can functionally link different habitat types or regions within a landscape. Elimination of landscape species may undermine these functional links and lead to cascading changes in ecological communities or even the loss of habitats and ecosystem functions critical to the persistence of other species, communities, and the larger landscape.

b) Landscape scale role

Habitat requirements of 'landscape species' populations explicitly define a large, diverse landscape that requires resource protection at that scale. All wildlife must have access to areas where food, shelter, and mates can be found. The size, composition, and spatial pattern of habitats that a species requires are all functions of diet, body-size, and the spatial and temporal patchiness of resource availability. Understanding the habitat requirements of a landscape species in time and space helps us to characterize the landscape that is biologically meaningful to that species. By mapping the composition, quantity, and spatial configuration of habitat patches required by a healthy, functioning population of a landscape species, we explicitly define the landscape necessary for its

long-term survival, and thus determine the appropriate scale for conservation management.

c) Threats assessment (vulnerability) role

Humans affect wildlife populations by harvesting them, by destroying or depleting important habitat or resources, and by killing individuals perceived as a hazard to life and livelihood. For landscape species to serve as effective tools for ranking the intensity and patterning of threats to wildlife and their habitat, they must themselves be sensitive to the human land-use and resource-use practices that constitute the threats.

d) Wilderness preservation role

These species do not require wilderness habitats per se, but because they require wilderness to avoid conflicts with humans and to avoid human-caused mortality. They also depend on free roaming naturally cycling prey populations. Because they are sensitive to human disturbance and need large tracks of wild land or wilderness to survive, their status signals impending environmental change across broad geographic areas. Only when protected landscapes are sufficiently large do wilderness-dependent species find refuge from humans.

e) Progress monitoring role

Monitoring the effectiveness of resource protection efforts is possible only if we have explicit targets against which we can track progress. Focusing conservation investments on reducing direct and indirect threats to individual landscape species and their habitats provides us with the explicit objectives that we need to monitor progress.

WCS 2002. The landscape species approach- a tool for site-based conservation, WCS, Bronx, N.Y.

6. Environmental Setting and Ecological Relationships: How does the Landscape Species Principle Relate to this Network of Parks?

The Southwest Alaska Network consists of five units of the National Park Service (Figure 1). Katmai National Park and Preserve (6,409 mi2), Alagnak Wild River (48 mi2), Aniakchak National Monument and Preserve (942 mi2), and Lake Clark National Park and Preserve (6,254 mi2) are managed as one administrative unit by a superintendent based in Anchorage and support staff based in King Salmon and Port Alsworth. Kenai Fjords National Park (2,710 mi2) is managed by a superintendent and support staff based in Seward. Collectively these units comprise 9.4 million acres or 2% of the Alaska landmass and include a diversity of geologic features, ecosystems, wildlife, and climatic conditions that are equaled in few places in North America.

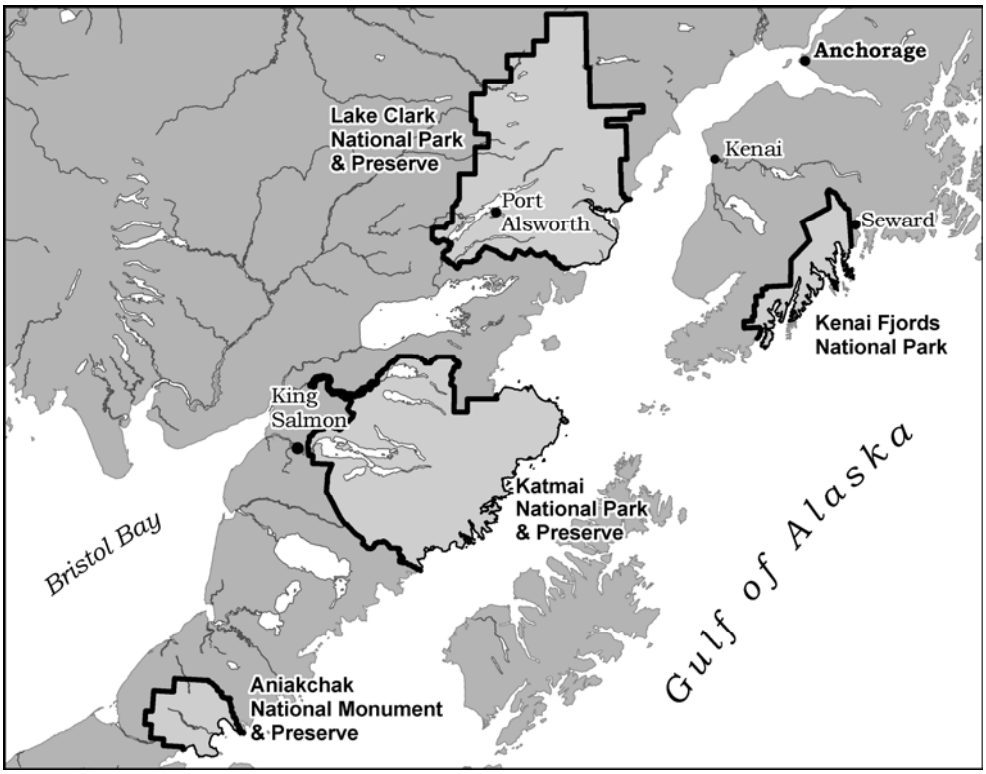


Figure 1. Southwest Alaska Network of National Park Units

Dynamic Landform Processes and Pattern- From steep glaciated fjords in the east to smoldering volcanoes on the western horizon, SWAN parks occur in one of the most geologically active regions of the continent. The network is located on an active tectonic shelf of the Pacific Ocean Plate in one of the most seismically erratic regions of the United States. During the 1964 earthquake lands within the Kenai Fjords subsided three to six vertical feet while in Lake Clark and Katmai coastal lands rose. There are at least seventeen "active" volcanoes in the network and Katmai National Monument was created to preserve the famed Valley of Ten Thousand Smokes, a spectacular forty square mile, 100 to 700 foot deep, pyroclastic ash flow deposited by the 1912 eruption of Novarupta Volcano. Aniakchak National Monument was created in recognition of the unique geological significance of its 6-mile-wide, 2,000-foot-deep *caldera* formed by the collapse of a 7,000-foot mountain.

Approximately one-fifth of the land mass of this network is covered by ice or permanent snowfields. Valley and tidewater glaciers radiate from massive snowfields along the coastal mountains of the 3 northernmost parks. Much of Kenai Fjords is a landscape of ice and tidewater glaciers formed by the forces of the Harding and Grewingk-Yalik icefields as they plunge into the sea. Ten of the thirty-four tidewater and hanging glaciers that emanate from Harding Icefield are included within the park.

Volcanic eruptions, tectonic forces, and glacial processes combine to make this network an important laboratory for both geologic research and long-term ecological studies of how landscapes respond to infrequent, large-scale disturbances. For example, a unique opportunity exists to observe pattern and relative timing of ice retreat, primary and secondary plant succession, patterns of animal colonization, and evolutionary processes.

Marine Coastline- SWAN parks contain approximately one-third of the marine coastline in the National Park System. This coastline spans 1,200 miles in the Northern Gulf of Alaska from the heavily glaciated Kenai Fords to Aniakchak on the Alaska Peninsula. The networks varied coastline, numerous freshwater sources, and diverse geomorphology generate many combinations of physical factors, creating a microcosm of the Northern Gulf of Alaska. Kenai Fjord's rocky headlands with extreme with wave exposure are contrasted with protected low energy beaches and tidal flats at Katmai and Lake Clark.

SWAN coastal waters in the northern Gulf of Alaska lie in one of the most biologically productive nearshore ecosystems in the world (Sambrotto and Lorenzen 1986). What makes this region so productive? In the Gulf of Alaska, high tides, frequent storms, and persistent currents stimulate strong, vertical mixing along the continental shelf. Mixing brings essential nutrients from depth up to the euphotic zone, where they support phytoplankton growth (Hood and Zimmerman 1986). Nutrient rich water upwelled by the Alaska Coastal Current affect the entire network coastline and contribute to high productivity (Burbank 1977, Lees et al. 1980).

Some key ecological features of the Network coastline include: 1) sheltered salt marshes and tidal flats that support lush brackish vegetation, large populations of benthic organisms, and serve as important feeding and resting areas for brown bears (*Ursus arctos*), shorebirds, and fish; 2) cliffs, headlands, and islands that support seabird rookeries and marine mammal haulouts; 3) eelgrass and kelp beds that provide herring spawning areas and a nursery substrate that supports the base of the nearshore food chain; and 4) tidally-influenced coastal freshwater streams that support wild stocks of anadromous salmon.

Aquatic systems, Anadromous Fish, and Ecological Interrelationships- Wild anadromous fishes link the ocean, fresh water, and land in important functional ways, supporting a complex food web that crosses the land-water interface. The interrelationships between anadromous salmon, terrestrial consumers such as brown bears, and the structure and function of both aquatic and terrestrial ecosystems is a flagship ecological resource of the network, and of national and international significance.

Network Parks contains some of the largest and most "pristine" freshwater resources in the National Park System. This includes the two largest lakes, Naknek Lake and Lake Clark, numerous multilake systems, and thousands of miles of rivers including five designated "Wild Rivers." Approximately 432,000 acres (12%) of Katmai is occupied by surface water. Aquatic systems in the western portions of Katmai and Lake Clark are so extensive that they form the template upon which biological systems at all levels are organized.

Aquatic systems in the network are pristine in the sense that 1) natural watershed process are operating including disturbances such as flood events and seasonal changes in flow; water quality is unimpaired; and aquatic fauna diversity and productivity vary naturally over both time and space. Aquatic and terrestrial animals

have likely had a very long, and probably co-evolutionary, relationship with salmon in each of these parks. For example, Johnson et al. (1997) examined the relationships between the Pacific salmon and wildlife in Washington and Oregon and found that of 138 wildlife species, 88 were characterized as having a routine relationship (consistent and recurrent) with salmon. The magnitude of salmon-wildlife-ecosystem relationships call attention to the consequences of loss or severe depletion of anadromous fish stocks and the role that long-term monitoring can play in tracking overall condition and changes in this ecological relationship.

Wilderness-dependent Large Mammal Species and Species Interactions- Despite hunting and other human activities, all parks in this network possess intact naturally functioning terrestrial ecosystems with their historic compliment of species. This includes large apex carnivores and predator-predator/predator-prey interactions. Intact functioning ecosystems with historic levels of biodiversity are becoming extremely rare globally and are a resource of great value locally and internationally.

Some key wilderness dependent mammals in SWAN are wolverines *(Gulo gul*o), brown bears *(Ursus arctos horribilis*), wolves *(Canis lupu*s), and lynx *(Lynx rufu*s). These species do not require wilderness habitats per se, but because they require wilderness to avoid conflicts with humans and to avoid human-caused mortality. They also depend on free roaming naturally cycling prey populations. Some key wilderness-dependent interactions include wolf-ungulate, brown bear-ungulate, carnivore-carnivore, predator-scavenger, and cyclic lynx-snowshoe hare (*Lepus americanus)* interactions.

Davis and Halvorson (1988) considered national park ecosystems to be “miner’s canaries” and nowhere is this concept more appropriate than when applied to wilderness-dependent species (Peek 1999). Because they are sensitive to human disturbance and need large tracks of wild land or wilderness to survive, their status signals impending environmental change across broad geographic areas. For example, wolverines are a classic wilderness-dependent species because they require large spatial areas with a full array of seasonal habitats, intact populations of prey, larger apex predators that provide scavenging opportunities, and refugia from human influences. Banci (1994) found that persistence of wolverine in southwestern Alberta is due entirely to the presence of large refugia, in the form of national parks. As wild ecosystems are progressively compromised by a variety of human activities such as mining, logging, recreation, and settlement, what is left becomes increasingly valuable as laboratories of natural ecological processes.

Ecoregion and Biological Diversity- Southwest Alaska parks are a place *where land and water meet.* Lake Clark National Park is often called “one park, four Alaska’s” referring to the diversity of landscapes relative to area. Although not as dramatic, this feature is shared by each of the network parks which collectively span 3 Alaskan climatic zones and 11 ecoregions. This landscape diversity is a product of the interaction of climate, terrain, and tectonics. Network parks exhibit examples of the major stages of Alaska’s history, including significant ongoing geological processes in the development of landforms; and examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, freshwater, and coastal ecosystems and their biotic communities.

Landscape diversity provides the template for relatively high biological diversity. Consequently, this region of Alaska is the crossroads for many species of plants and animals. Peninsulas have been conceptualized as resembling a chain of islands upon which species may "hop" in order to disperse from mainland populations to the distal ends of the peninsula (Noss and Cooperrider 1994). Numerous species of animals such as Dall sheep, black bear, and Trumpeter Swans and plant communities such as coastal rainforest and boreal forest reach the limits of their state-wide range in Southwest network parks.

Climate change and its influence on the distribution of plants and animals in this network have broad implications for long-term monitoring. The geographic ranges of most plant and animal species are limited by climatic factors, including temperature, precipitation, soil moisture, humidity, and wind. Peninsula landmasses are likely to respond to climate change more rapidly and severely than insular areas because of a greater coast/interior ratio (Suffling and Scott 2002). Colonization by new species, distribution shifts by existing species, or changes in life cycle patterns such as the timing of migrations, all have implications for park management and resource protection.

7. Vegetation Overview

Aniakchak- Aniakchak volcano: Large expanses of cinder and tephra plains surround the crater itself. This area is largely barren, with scattered willow and forb patches around the edges and in lower drainages. Inside the caldera, wet herb and sedge meadows are concentrated near Surprise Lake. Patches of willow, *Calmagrostis,* and *Empetrum* heath are scattered around the floor of the crater.

Coastal side: The Cinder river drainage to the north and east of the caldera has relatively lush willow stands and grass/forb meadows with patches of *Empetrum* heath or wetlands. Alder patches grow in the valleys above the cinder plains. The upper Meshik River valley appears to be dominated by wetlands, and probably *Empetrum* heath. The coastlands are probably dominated by *Calamagrostis* and forb meadows, alder patches and *Empetrum* heath.

Katmai and Alagnak River- Bristol Bay lowlands, moraines and lakes: Wetlands support communities dominated by sedges, mosses and dwarf shrubs. Wetland and pond complexes provide nesting and rearing habitat for many species of waterfowl and shorebirds. Slight ridges are better drained and support "subforests" of white spruce and Kenai birch, with alder thickets and patches of *Calmagrostis* grasslands. The southernmost extent of white spruce on the Alaska Peninsula is just south of King Salmon. Glacial moraines support spruce and birch/balsam poplar forests with low and dwarf shrub communities in the understory and openings. The unit around Lake Colville supports wetlands and fairly dense spruce forests on the higher ground and side slopes. Lacustrine deposits and old lake terraces west of Brooks and Naknek Lakes are vegetated with sedge/low shrub tundra and open alder stands.

Mountains: The Kejulik and Cape Douglas Mountains are permanently glaciated, with valley glaciers nearly reaching the Shelikof coast. Below barren, exposed ridgetops and outcrops, patches of alpine tundra and low shrubs find footholds in sheltered niches and shallower patches of ash from the 1912 Katmai eruption. Lower slopes support dense alder stands, with a few Sitka spruce on the coastal headlands. Several valleys around Novarupta and Katmai, and slopes on the eastern side of the range, are still covered with deep ash deposits that remain unvegetated. The Walatka mountains and Kamishak highlands support dwarf shrub and alpine tundras at higher elevations, with dense alder on lower slopes and cottonwood stands along the streams in the lowest valleys. Beaver help shape floodplains of streams from sea level to the upper limits of alpine low willow. Portions of the large west-flowing river valleys are forested with white spruce, with balsam poplar along the floodplains.

Coastlands: are generally unstable, but adapted to repeated disturbances, and support early successional communities of sedges, aquatic forbs and grasses. Alder and elderberry patches provide nitrogen for the soils, and sheltered sites support stands of Sitka spruce.

Kenai Fjords- Gravel beaches grade into a supra-tidal community of beach ryegrass, beachpea and *Hockenyna* with scattered flowering forbs such as iris and jacob's ladder. Protected lagoons, like the backs of James and Beauty Bay have rich beds of goose tongue, a favorite spring food for bears. Exposed rocky cliffs have tufts of grasses and perennial forbs, some richly fertilized and aerated by puffin nests.

Alder stands and Sitka spruce/hemlock forests begin immediately above the storm tide zone. Alder is a rapid invader in disturbed zones, following avalanche tracks from the alpine down to tide line. Scattered grasses and forbs find a foothold under the shrubs. Alder provides nitrogen for recently de-glaciated soils, enriching the environment for spruce invasion. Sitka spruce appears to move into de-glaciated terrain within 20 years of ice retreat. Recently developed Sitka spruce stands have uniform aged trees with a thin moss ground cover, scattered grasses and shrubs such as salmon berry and *Menziesia*. Older stands, growing through the last glacial maximum, have spruce of varying ages, thick moss ground cover and on the tree limbs, with alder, salmonberry and Devil's club in openings. It appears that there were spruce forest refugia perched in high valleys above the ice limits that are now providing seed sources miles up-valley of the glacial terminus forests.

Alder thickets and open stands extend above the forested zone along the coast up to a narrow band of alpine tundra, which quickly grades into bare rock and ice. Glacial retreats have formed several wide valleys, which have broad braided floodplains. On the coast these floodplains are covered with stands of alder and willow, while cottonwood is an additional component at the Exit Creek floodplain.

Lake Clark- Coastal side: The Cook Inlet coastline is characterized by a narrow band of coastal salt marshes in Tuxedni and Chinitna Bays and scattered marshes and lagoons along the outer coast. Coastal zones without marshes have long gravel beaches or bedrock cliffs rising abruptly out of Cook Inlet. The salt marshes are a rich

zone of sedges and some grasses with varying tolerance to salt water flooding, and form an early spring food source for bears grazing along the beaches. Much of the Lake Clark coast appears to be rising from tectonic movements and narrow bands of young spruce are establishing themselves into the *Elymus* grass community back of the beaches. The depositional flats and lower mountainsides behind the beaches are covered with spruce forests and alder thickets. Both white and Sitka spruce grow along the coast, with Sitka generally south of the Johnson river, and white spruce to the north. Conifer forests have multi-aged trees with thick moss understory, devil's club, salmonberry and scattered alder. Scattered stands of spruce rise out of a sea of alder, especially around the Tuxedni coast and above the dense spruce forest. Alder thickets grow above the spruce zone, thinning out into *Calamagrostis* meadows at the upper limits. The alpine tundra zone is very narrow on the coastal side of the mountains, dominated by *Luetka* and *Empetrum* and forbs. Tundra yields to bedrock and ice.

Lake side: The western side of the park is dominated by a series of large long lakes with their eastern extents in the Alaska Range, and pushing out to the terminal moraines from the most recent advances of large valley glaciers. Low ridges and subdued mountains lie between the lake systems. The northern part of the park, by the Stony river, is boreal in character, with black spruce, muskegs, aspen and birch, and wildfire. Further south, vegetation is a mosaic of spruce and mixed spruce/birch or cottonwood forests, paper birch, low shrubs dominated by dwarf birch, dwarf shrub tundra with ericaceous shrubs, scattered wetlands and alpine tundra. Vegetation patterns are arrayed in response to soil texture and drainage patterns from a complex glacial and alluvial history.

Mountainous spine: The center of the park is primarily glacial ice and bedrock or till. Most valley glaciers are in retreat, leaving large expanses of moraines and ground till, which is slowly revegetating with mosses and lichens, fireweed and Dryas, willow and alder. An ecosystem of note is the expansive shallow wetlands along the Neacola river, which runs into Chakachamna Lake. This valley provides rich habitat for beaver, moose, nesting waterfall and bear. The wetlands appear to be dominated by sedges and willows, and are maintained by flooding and beaver activity.

8. Fauna Overview and human-related protection concerns

Aniakchak

Terrestrial Mammals

Thirty terrestrial mammal species are documented or are expected to occur within ANIA (NPSpecies database, 2002). Some of the more commonly observed species include brown bear, moose, caribou, red fox, Arctic ground squirrel, and tundra vole. Species less frequently observed include wolf, river otter, wolverine, porcupine, and beaver. Information on the distribution, abundance, and breeding status of most terrestrial mammal species is limited. Existing survey and research data are described below. Much of the limited available information regarding terrestrial mammal species distribution and abundance has come from incidental records of mammal sightings noted by scientists and NPS staff that have visited the monument.

ANILCA specifically provides for sport and subsistence trapping and hunting of wildlife in Aniakchak National Preserve, and for subsistence hunting and trapping in Aniakchak National Monument, consistent with applicable federal and state laws and regulations. The preserve encompasses about 80% of ANIA. To protect subsistence uses and manage for healthy wildlife populations, the NPS issues concession contracts for sport hunting guide-outfitter services within Aniakchak National Preserve. The concessions contracts limit guided hunts to any species that may be legally taken under state non-subsistence regulations. Currently there are three guide areas in ANIA. ANIA receives copies of state reporting forms for animals harvested by contracted guides. The NPS also periodically receives updated copies of the state's harvest database and sealing records.

Brown bear.—Because of the moderate climate in the ANIA area, bears may enter dens as late as December, and emerge in early May. Denning within ANIA is known to occur on the slopes of the caldera and areas on the east side of the Aleutian Range (NPS 1986). Bears descend to the coastal plains in spring, where they feed on caribou and moose calves and adults, marine mammal carcasses and other carrion, and on green vegetation. Spring bear aggregations have been noted in Aniakchak Bay and Amber Bay. Salmon begin arriving on the Pacific side before they arrive on the Bristol Bay side of ANIA. Bears appear to primarily distribute themselves relative to salmon availability from June through September. In August bears begin to supplement their diet with ripening berries. Stroud and Fuller (1983) reported timing of drainage use for areas that they patrolled. Sowl (1988) noted that bears frequented Aniakchak Caldera once salmon began spawning there mid to late August. Salmon may be available in some drainages through late fall and early winter.

No brown bear research has been conducted in ANIA. However research was conducted from 1988 through 1996 at Black Lake, about 48 km southwest of ANIA, to assess brown bear population status (Sellers 1994, ADF&G 2003). Part of this research involved evaluating the effectiveness of aerial surveys of bears along salmon streams to detect population trends.

Available data suggest that the Alaska Peninsula brown bear population may have been overharvested in 1972-1973 (Sellers and McNay 1984). Beginning in 1976, annual hunting seasons have been alternated between spring and fall throughout Game Management Unit 9. Surveys continue to suggest that the bear population on the Alaska Peninsula has increased since the 1960s (Sellers and McNay 1984, ADF&G 2003). At least 21 bears were harvested within Aniakchak National Preserve during the 1999 regulatory year, and at least 17 were taken

in the 1997 regulatory year (a regulatory year includes a fall and spring bear hunt) (ADF&G sealing records database).

Gray wolf.—Little is presently known about the numbers and range of wolves in ANIA. Sellers (1990a) reported that wolves occur at low to moderate densities throughout the Alaska Peninsula. However, data on numbers and distribution were derived only from hide sealing records and anecdotal observations.

Moose.— Moose have been on the Alaska Peninsula since the early 1900s, but did not become abundant until the 1950s. Local residents first reported seeing moose in the Chignik area in the mid 1940s (NPS 1993). The population peaked in the late 1960s, and the Alaska Peninsula became world renowned for trophy moose. Comparisons of trend surveys from 1969-1972 with those from 1982-1983 indicated moose numbers had declined by 60% or more (Sellers 1990b). The decline of moose numbers during the 1970s apparently resulted from low calf recruitment, after moose over-browsed their range. Predation on neonate calves by brown bears on the peninsula appeared to be a major factor preventing an increase in moose density even after range conditions had improved (Sellers 1990b).

In ANIA, moose primarily range over the lower willow- and alder-lined slopes and valleys, with concentrations along the upper Meshik and Cinder River valleys, and at the head of Amber Bay. The Alaska Department of Fish and Game (ADF&G) has established trend areas where aerial surveys of the moose population are carried out to monitor age and sex composition. Two of these trend areas encompass moderate to high quality moose wintering habitat in ANIA—one is centered around the Cinder River in the northern portion of ANIA, and the other includes coastal habitat in the southeast corner of ANIA. A new trend area, which has only been flown once to date, encompasses moose wintering habitat in the southwest portion of the preserve (KATM/ANIA, unpubl. data, 1999). ADF&G, NPS, and the U.S. Fish and Wildlife Service (USFWS), cooperatively work on surveying the trend areas. Ideally, each area is surveyed every one to three years. Poor snow and weather conditions have sometimes hampered efforts to survey the trend areas that include ANIA. Trend area surveys since the early 1980s indicate that the Peninsula population has remained relatively stable (R. A. Sellers, ADF&G, unpubl. data). The USFWS plans to use line transect sampling to estimate moose density in Game Management Unit 9(E), which includes ANIA. KATM has submitted a project funding proposal to participate in this effort.

Caribou.— The Northern Alaska Peninsula Caribou Herd (NAP) calves on the Bristol Bay coastal plain, and traditionally winters between the Egegik and Naknek Rivers (ADF&G 2003). Some NAP caribou may calve within ANIA, and in recent years as many as 500 NAP caribou have summered within the unit (R. Squibb, USFWS, personal comm.).

From 1981-1993, the NAP remained relatively stable with between 15,000-20,00 animals. Since that time, herd size has declined. In 2001 and 2002 post-calving counts remained at about 6,400 animals (ADF&G 2003). Cooperative studies by ADF&G and the USFWS and other indicators suggest that deteriorating range condition were the primary cause of the NAP decline (ADF&G 2003).

Furbearers.—To date, no ANIA furbearers have been formally surveyed.

Small Mammals.—Four short-term small mammal surveys have been conducted in ANIA: one at Aniakchak Bay (T.W. Trapp, ANIA, unpubl. data, 1992), and two in the caldera (Jarell 1987; T.W. Trapp, ANIA, unpubl. data, 1992). These surveys documented the presence of specific small mammal species. Jarell's (1987) trapping efforts suggested that masked shrew, dusky

shrew, meadow vole, and arctic ground squirrels were the most common and widespread species in the caldera.

Birds

About 129 bird species are documented or expected to occur within ANIA, including 47 landbird species, 47 inland waterbird species, and 35 seabird species (NPSpecies database, 2002). Studies and surveys of bird species in ANIA are few—surveys for nesting bald eagles have been conducted (see below), and an effort was made to survey bird species in Aniakchak Caldera in 1987 (Meyer 1987). Therefore, information on bird species largely consists of anecdotal sighting records noted by NPS ranger and resource management staff.

Some of the more regularly noted landbird and inland waterbird species in patrol reports (locations and timing of patrols and surveys varied—some included Anaikchak Caldera) include red-throated loon, greater scaup, harlequin duck, Barrow's goldeneye, common merganser, bald eagle, rough legged hawk, sandhill crane (seasonal), semipalmated plover, lesser yellowlegs, wandering tattler, whimbrel, western sandpiper, least sandpiper, rock sandpiper, common snipe, red-necked phalarope, belted kingfisher, tree swallow, bank swallow, common raven, hermit thrush, American dipper, American pipit, savannah sparrow, golden-crowned sparrow, lapland longspur, snow bunting, rosy finch, and common redpoll (Stroud and Fuller 1983, Manski et al. 1987, Meyer 1987, Sowl 1988, Starr and Starr 1988a, Savage 1993). Peregrine falcon and gyrfalcon sightings are infrequent, but have been noted in a number of NPS patrol and survey reports. Some of the more common seabird species in anecdotal records include cormorants, black oystercatcher, mew gull, glaucous-winged gull, black-legged kittiwake, arctic tern, common murre, pigeon guillemot, marbled murrelet, kittlitz's murrelet, ancient murrelet, and horned puffin (Stroud and Fuller 1983, Manski et al. 1987, Meyer 1987, Sowl 1988, Starr and Starr 1988a, Savage 1993)

The Boreal Partners in Flight Working Group identified six landbird species as "priority species" for western/southwestern Alaska—gyrfalcon, gray-cheeked thrush, varied thrush, golden-crowned sparrow, McKay's bunting, and hoary redpoll (Andres 1999). Gyrfalcons are uncommon in anecdotal sighting records, but similar to peregrine falcon, they are noted on occasion in NPS patrol and survey reports. Meyer (1987), Sowl (1988) and Savage (1993) described golden-crowned sparrow as a common species in Aniakchak Caldera, and Sowl (1988) described evidence of nesting there. Golden-crowned sparrows were also described as abundant on the ANIA coast by Manski et al. (1987).

Bald eagle.—Bald eagles can be commonly found nesting and feeding along rivers and the coastline of ANIA. They have also been observed within Aniakchak Caldera and on the cliffs north of Meshik Lake (NPS 1986). An aerial raptor survey was conducted along the ANIA coast in 1988 (Starr and Starr 1988b). Aerial surveys of the ANIA coast for bald eagle nests and productivity were conducted in 1989 and 1990 in an effort to monitor impacts of the *Exxon Valdez* oil spill (Payer 1989, Dewhurst 1990). An adult bald eagle survey of the entire Alaska Peninsula was conducted by USFWS during late April 2000. The stratified random plot quadrat sampling included 2 sample plots that encompassed the Amber Bay coastline and vicinity (Savage and Hodges 2000).

Terrestrial Threatened and Endangered Species

Currently no federally listed species are known to occur in terrestrial areas of ANIA. The USFWS formerly listed some wildlife species as category 2 candidate species, which indicated that further research was needed to assess biological vulnerability, taxonomy and/or threats. This designation was discontinued in 1996, and those species are now referred to by the

USFWS as “species of concern.” Harlequin duck is a species of concern that occurs in terrestrial areas of ANIA. Lynx, which is also a former category 2 species, is at the southern boundary of its range in ANIA, and sightings are rare.

Management/Human Use Issues

Hard mineral and oil and gas deposits have been identified within and off the coast of ANIA. ANIA is currently one of the least developed units in the National Park System. Mineral development could have significant effects on the natural resources of ANIA, as could offshore oil and gas development. Considerable land has been selected either as fee simple or mineral rights within the ANIA boundary by a regional native corporation, and smaller portions of land have been selected by village corporations. The state of Alaska selected about 5,000 acres in the northeast section of Aniakchak.

Certain types of illegal access are sometimes used to enter ANIA. This includes use of ORVs along the Pacific coast and occasionally from Port Heiden.

Non-consumptive recreational visitation is limited and typically focuses on small areas in the most accessible locations. The result is a pattern of use of a few dispersed places. More than 90% of ANIA’s visitation is by guided hunters and anglers (NPS 1986). Several hundred people fish along backcountry streams in ANIA. A handful of people hike the ANIA backcountry. Some visitors use rafts to float rivers, camping along the way.

Because there is no staff stationed near the unit, tracking of visitor use as been problematic. Even when staff is stationed in ANIA seasonally, the expanse of land is too large to monitor for visitation. Commercial operators have provided information to concession staff regarding their use of ANIA, and a few unguided visitors have obtained backcountry permits that allow the park to track use. In 2000 a total of 328 visitor days were recorded, and in 2001, 283 visitor days were documented. Due to the limited sources for visitor use information, these numbers are recognized to be significant underestimates of actual use.

Literature Cited

Alaska Department of Fish and Game (ADF&G). 2003. Region II briefing book, January 2003. Alaska Department of Fish and Game, Division of Wildlife Conservation, Juneau, Alaska, USA.

Dewhurst, D.A. 1990. Bald eagle nesting and reproductive success along the Pacific coast of the Alaska Peninsula Cape Kubugakli to American Bay, 9 May-28 July, 1990. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof National Wildlife Refuge Complex, King Salmon, Alaska, USA.

Jarell, G.H. 1987. Small mammal survey of Aniakchak Caldera. Report prepared for the National Park Service by the University of Alaska Museum, Fairbanks, Alaska, USA.

Mahoney, B.A., and G.M. Sonnevil. Surprise Lake and Aniakchak River fishery investigation, Aniakchak National Monument and Preserve, Alaska, 1987 and 1988 final report. U.S. Fish and Wildlife Service, Alaska Fisheries Technical Report No. 12.

Meyer, K. 1987 bird surveys of Aniakchak Caldera. Aniakchak National Monument and Preserve, King Salmon, Alaska, USA.

Miller, T.P., and R.L. Smith. 1987. Late quaternary caldera-forming eruptions in the eastern Aleutian arc, Alaska. Geology 5:434-438.

National Park Service (NPS). 1986. Aniakchak National Monument and Preserve general management plan, land protection plan, wilderness suitability review. U.S. Department of the Interior, National Park Service, Denver Service Center, Denver, Colorado, USA.

National Park Service (NPS). 1993. Draft resource management plan. Aniakchak National Monument and Preserve, King Salmon, Alaska, USA.

Payer, D.C. 1989. Biological resources survey and oil spill impact assessment: Aniakchak National Preserv. Aniakchak National Monument and Preserve, King Salmon, Alaska.

Savage, S. 1993. Annotated bird list, Aniakchak Caldera and surrounds, field season 1993. Aniakchak National Monument and Preserve, King Salmon, Alaska, USA.

Savage, S., and J. Hodges. Bald eagle survey, Pacific coast of the Alaska Peninsula, Alaska, spring 2000. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof Wildlife Refuge Complex, King Salmon, Alaska, USA.

Sellers, R.A. 1994. Dynamics of a hunted bear population at Black Lake, Alaska, 1993 annual progress report. Alaska Department of Fish and Game, Division of Wildlife Conservation, Juneau, Alaska, USA.

Sellers, R.A., and McNay, M. 1984. Population status and management considerations of brown bear, caribou, moose, and wolves on the Alaska Peninsula. Report to the Board of Game, Alaska Department of Fish and Game, King Salmon, Alaska, USA.

Sowl, K. Investigations of the flora and fauna inside Aniakchak Caldera, June to September 1988. Aniakchak National Monument and Preserve, King Salmon, Alaska, USA.

Starr, F., and P. Starr. 1988a. Annotated bird observations, Aniakchak coast, June 17 – August 30, 1988. Aniakchak National Monument and Preserve, King Salmon, Alaska, USA.

Starr, F., and P. Starr. 1988b. Coastal raptor survey. Aniakchak National Monument and Preserve, King Salmon, Alaska, USA.

Katmai and Alagnak River

Terrestrial Mammals

Thirty-five terrestrial mammal species are documented or are expected to occur within KATM (NPSpecies database, 2002). Commonly observed species include brown bear, moose, caribou, red fox, ermine, mink, porcupine, beaver, Alaskan hare, snowshoe hare, red squirrel, Arctic ground squirrel, northern red-backed vole, and little brown bat. Species less frequently observed include wolf, coyote, lynx, river otter, wolverine, and marten. KATM maintains records of anecdotal observations reported by park staff and visitors, and some anecdotal observations have also been documented in patrol reports and unpublished resource management project reports. Although a few species, particularly brown bear, have been studied, information on the distribution and abundance of most mammal species is limited to these records.

ANILCA specifically provides for sport and subsistence trapping and hunting of wildlife in Katmai National Preserve, consistent with applicable federal and state law and regulations. The preserve encompasses approximately 413,000 acres of the northwest corner of KATM (about 11% of KATM). To protect subsistence uses and manage for healthy wildlife populations, the NPS issues concession contracts for sport hunting guide-outfitter services within Katmai National Preserve. The concessions contracts limit guided hunts to any species that may be legally taken under state non-subsistence regulations. Currently there are 2 guide areas in Katmai National Preserve. KATM receives copies of state reporting forms for animals harvested by contracted guides. The NPS also periodically receives updated copies of the state's harvest database and fur sealing records.

Brown bear.—Most bears emerge from their dens by mid-May. During the spring bears feed on sedges, grasses, forbs, carrion, and moose calves in some areas. On the coast, bears congregate to feed on salt marshes located in many of the large bays. Some bears also feed on marine invertebrates available in adjacent intertidal habitat. As the season progresses, spawning salmon become a primary food source for bears, and the distribution of bears largely reflects the distribution of salmon. Bears congregate at numerous salmon spawning streams throughout the Park and Preserve. Salmon are available in a few streams as early as late June, and in some streams as late as October. During August, berries also become an important food item throughout the Park and Preserve. Information on bears numbers, composition, and timing of use has been obtained for selected salmon streams and coastal sites via aerial stream surveys and observational monitoring and research projects (Troyer 1974a, Troyer 1976a, Troyer 1977a, Troyer 1977b, Troyer 1978a, Troyer 1980a, Jope and Casebeer1983, Jope 1984a, Jope 1985a, Jope 1986a; KATM, unpubl. data, 1988, 1992, and 1993). However, differences in survey methods and observer and pilot experience among years have made multi-year comparisons of the data problematic.

To assess the effects of the *Exxon Valdez* oil spill on brown bears, a study was conducted on the KATM coast from 1989-92 to monitor the survival and productivity of radio-collared females, measure levels of hydrocarbons in fecal samples, and estimate population density (Sellers and Miller 1999, Sellers et al. 1999). Capture mark-resight techniques (CMR) were used to estimate the brown bear density for a 901-km² KATM coastal study area (Sellers et al. 1999). For bears of all ages, the CMR density estimate was 0.5 bears/km^2, the highest density ever reported in North America (based on 1990 data; Miller et al. 1997). Data on survival rates, sources of mortality, and bear productivity were also obtained from the radio-collared bears, and from collaring and tracking the activities of additional bears collared in 1993 (Sellers et al. 1999). The density estimates and subjective impressions of the relative density of bears in different parts of

the Park were used to extrapolate to a bear population estimate of 1,500 to 2,000 bears for the entire KATM (Sellers et al. 1999). This total includes an estimated 131-184 bears in Katmai National Preserve (a density of 0.1 - 0.2 bears/km^2) (Sellers et al. 1999).

Observational research has been conducted into the effects of human activity on bear use at several locations in KATM (Beattie 1983, Braaten and Gilbert 1987, Warner 1987, Braaten 1988, Olson et al. 1990; Olson and Squibb 1990; Olson and Squibb 1991; Olson 1993; Olson and Gilbert 1994; Olson et al. 1997a, 1997b; French et al. 2001; Smith et al. 2001). In addition, the effects of a new viewing structure and boardwalk have been investigated at Brooks River (Peirce and DeBruyn 1999a; T.D.DeBruyn, NPS Alaska Support Office, manuscript in prep.), use of soft-shelled and Pacific razor clams by coastal bears has been investigated (T.S. Smith, USGS Alaska Science Center, manuscript in review), bear use of Brooks River has been monitored annually since 1999 using observational sampling methods (KATM unpubl. data, 1999-2001) bear use of the Moraine-Funnel Creek confluence has been documented (K. Proffitt, KATM, manuscript in prep.; T.L. Olson, KATM, manuscript in prep.), human-bear interactions and bear activity at Big River on the KATM coast has been investigated (T. Smith and S. Partridge, USGS Alaska Science Center, unpubl. data), and bear responses to novel sight sounds and odors has been researched (T. Smith, USGS Alaska Science Center, unpubl. data). Most of these research and monitoring projects have produced annual estimates of the number and composition of bears that used the study area based on individual bear identification records. At Brooks River, these data have been obtained using observational sampling methods in most years since 1985. Although not based on structured sampling, bear numbers and composition at Brooks River have also been periodically estimated since 1976 by resource management staff (Troyer 1980b, DeBruyn and Peirce 1999, KATM unpubl. data).

Since 1990, bear-human interactions and bear-management related events have been documented using bear management report forms (BMRF) (Holmes 1991, Holmes 1992, Holmes 1993, Holmes 1994, Boyd 1996, Boyd 1997, Carden and McFarland 1998, Peirce and Debruyn 1999b, Proffitt 2002, Olson et al. 2002, NPS 2001, KATM unpubl. data). Because reports are recorded opportunistically, for the most part the records cannot be used to compare frequency of incidents among sites, years, etc. However, use of BMRFs has resulted in more consistent documentation of events, and the records can be used to derive minimum estimates of occurrence

In the past 10 years, brown bear harvest per regulatory year (includes a fall and a spring bear hunt) in Katmai National Preserve has ranged from 10 to 19 bears, an average of 7 bears per year (ADF&G bear fur sealing database).

Gray wolf.—Little is presently known about the numbers and range of wolves in KATM. Sellers (1990a) reported that wolves occur at low to moderate densities throughout the Alaska Peninsula. However, data on numbers and distribution were derived only from hide sealing records and anecdotal observations. Park sighting records suggest the existence of at least four or five small wolf packs within and adjacent to KATM.

Moose.— Moose have been on the Alaska Peninsula since the early 1900s, but did not become abundant until the 1950s. The population peaked in the late 1960s, and the Alaska Peninsula became world renowned for trophy moose. Comparisons of trend surveys from 1969-1972 with those from 1982-1983 indicated moose numbers had declined by 60% or more (Sellers 1990b). The decline of moose numbers during the 1970s had apparently resulted from low calf recruitment, after moose over-browsed their range. Predation on neonate calves by brown bears on the peninsula appeared to be a major factor preventing an increase in moose density even after range conditions had improved (Sellers 1990b).

The Alaska Department of Fish and Game (ADF&G) has established trend areas where aerial surveys of the moose population are carried out to monitor age and sex composition. These include areas along the Park and Preserve boundary (the oldest area dates back to 1969). ADF&G, NPS, and the U.S. Fish and Wildlife Service (USFWS), cooperatively work on surveying the trend areas. Typically, each area is surveyed every one to three years. Moose trend area surveys since the early 1980s indicate that the Peninsula population has remained relatively stable (R. A. Sellers, ADF&G, unpubl. data).

Other moose surveys that have been conducted in Katmai National Park include a moose parturition survey of the central western part of the park in 1985 (Sellers 1985) and a winter moose survey of most drainage's in the park in 1975 (Troyer 1975a).

The most recent moose density estimate reported for Game Management Unit 9 (0.3 moose/ km^2; Sellers 1990a) dates back nearly 20 years, and was for a 1,314-mi^2 area of primary moose habitat in central GMU 9(E). The best moose habitat, which is similar in quality to moose habitat in the park boundary trend area, had an average of 0.9 moose/ km^2.

Caribou.— The Northern Alaska Peninsula Caribou Herd (NAP) calves on the Bristol Bay coastal plain (southwest of KATM), and traditionally winters between the Egegik and Naknek Rivers. Prior to 1986, NAP caribou were generally found only in areas along the southwest boundary of KATM, including the Angle/Takayofo drainage and the headwaters of the Brooks drainage. Other than the occasional bands found in the King Salmon Creek drainage, it was unusual for caribou of the NAP to travel north of the Naknek River, or for caribou of the Mulchatna herd to travel south of the Kvichak River (which is northwest of the KATM boundary). However, since that time Mulchatna caribou have been travelling further south during the winter and have intermingled with the NAP in the area between the Naknek River and Lake Iliamna. By 1991, caribou wintering areas included the western areas of the park east of Dumpling Mountain (near Brooks River), as well as parts of Katmai National Preserve. A portion of the NAP now crosses, or attempts to cross, the Naknek River between King Salmon and the Naknek Lake outlet during their northward fall migration. The narrow band of NPS land between the Naknek lake outlet and Lake Camp provides the only protected passage for the herd to pass (although hunting continues on privately owned inholdings).

From 1981-1993, the NAP remained relatively stable with between 15,000-20,00 animals. Since that time, herd size has declined. In 2001 and 2002 post-calving counts remained at about 6,400 animals (ADF&G 2003). Cooperative studies by ADF&G and the USFWS and other indicators suggest that deteriorating range condition were the primary cause of the NAP decline (ADF&G 2003).

Furbearers.—To date, no KATM furbearers have been formally surveyed.

Small Mammals.— Aside from collection of a few specimens during biological reconnaissance work in Katmai National Monument, little is known about small mammals in KATM. A limited trapping study was conducted in the summer of 1973 at three sites in the monument (Dennis 1973). Systematic hare counts were recorded along the VTTS road during the summer of 1992-1992 and 1994 (Holmes 1992a, Holmes 1994a).

Birds

About 180 bird species are documented or expected to occur within KATM, including 81 landbird species, 64 inland waterbird species, and 35 seabird species (NPSpecies database, 2002).

Most landbird surveys in KATM have focused on nesting bald eagles. Breeding bird surveys (BBS) were conducted along the Valley of Ten Thousand Smokes Road (VTTS) from 1992-96 and in 2000. (S. Savage, KATM, unpubl. data). The Boreal Partners in Flight Working Group identified six landbird species as "priority species" for western/southwestern Alaska—gyrfalcon, gray-cheeked thrush, varied thrush, golden-crowned sparrow, McKay's bunting, and hoary redpoll (Andres 1999). Gyrfalcons are uncommon in anecdotal sighting records; an active gyrfalcon nest and a second pair of gyrfalcons were documented in 1993 in KATM during an aerial peregrine falcon survey (White et al. 1993). Gray-cheeked thrush, varied thrush, and golden-crowned sparrow were documented in all years of the VTTS BBS (S. Savage, KATM, unpubl. data).

Most waterbird surveys in KATM have occurred as part of broader-scale survey efforts conducted by the USFWS. Spring waterfowl surveys of the Naknek River have been conducted by the USFWS in most years since 1983 (Burke 1992, Cook 1992, Mehall 1993, Moore 1996, Ruhl and Moore 1996, Alaska Peninsula/Becharof National Wildlife Refuge, unpubl. data). A ground-based multi-point component was added to these surveys in 1991, which includes a survey point at Lake Camp within KATM. In addition, a waterfowl fall staging survey was conducted along the Naknek River using the same ground-based observation points (Scharf 1993). Major breeding populations of ducks and other waterbirds have been surveyed by aircraft in Alaska every spring since 1957 as part of the North American Waterfowl Breeding Pair Survey. This survey includes transects in the Bristol Bay area (Conant et al. 2000). Between 1993-1994, this survey was expanded to include more intensive transect survey efforts (Platte and Butler 1995). Waterbird distribution maps, which include some western portions of KATM, were produced based on these surveys (Platte and Butler 1995). Aerial surveys of random sample plots of habitat thought to contain swan habitat were flown on the Alaska Peninsula in 1991 to derive population estimates (USFWS 1991), and Wilk (1988) conducted aerial surveys to document tundra swan distribution, abundance, population structure, and productivity in Bristol Bay. The tundra swan surveys included some western portions of KATM.

Some of the landbird and inland waterbird species more commonly recorded in anecdotal sighting records in recent years at Brooks River (late spring through fall) and during the VTTS BBS include common loon, red-necked grebe, tundra swan, green-winged teal, mallard, American wigeon, greater scaup, harlequin duck, common goldeneye, Barrow's goldeneye, common merganser, red-breasted merganser, osprey, bald eagle, northern harrier, northern goshawk, spruce grouse, rock ptarmigan, willow ptarmigan, semipalmated plover, greater yellowlegs, spotted sandpiper, black turnstone, surfbird, common snipe, great-horned owl, belted kingfisher, downy woodpecker, three-toed woodpecker, tree swallow, violet-green swallow, bank swallow, gray jay, black-billed magpie, common raven, black-capped chickadee, boreal chickadee, brown creeper, American dipper, golden-crowned kinglet, ruby-crowned kinglet, gray-cheeked thrush, Swainson's thrush, hermit thrush, American robin, varied thrush, American pipit, orange-crowned warbler, yellow-rumped warbler, blackpoll warbler, northern waterthrush, Wilson's warbler, American tree sparrow, savannah sparrow, golden-crowned sparrow, white-crowned sparrow, dark-eyed junco, snow bunting, white-winged crossbill, and common redpoll. Other landbird and inland waterbird species commonly noted in NPS staff reports for the KATM coast include black scoter, white-winged scoter, surf scoter, northwestern crow, yellow warbler, and fox sparrow (LaFrance and Peterson 1991, Litch and Blackie 1988, Starr and Starr 1992)

Surveys of seabirds nesting along the coast of KATM were conducted in 1973, 1981, 1988, 1989, and 1993 (Bailey and Faust 1984; Litch and Blackie 1988; Martin 1989; and R. Potts, KATM, unpubl. data, 1993). Roughly half of the park seabirds are located on Ninagiak Island (Bailey and Faust 1984), where puffin and gull ground-nesting colonies predominate. Some of

the more common seabird species in the USFWS seabird colony database for the KATM coast include cormorants, glaucous-winged gull, black-legged kittwake, pigeon guillemot, tufted puffin, and horned puffin. Less common species include common eider and parakeet auklet. Other common seabird species noted by NPS staff in patrol and survey reports include mew gull, pigeon guillemot, and marbled murrelet (Starr and Starr 1992).

Peregrine falcon.— Although sightings are infrequent, peregrine falcon sightings have been typically reported in KATM coastal patrol reports. White et al. (1993) reported that peregrine nests have only been confirmed or were probable in 2 coastal areas of KATM (Cape Douglas and Amalik Bay). The Amalik Bay nest was observed in 1992 (Starr and Starr 1992). Bailey and Faust (1984) observed only one active peregrine nest, and two other suspected nests during a boat-based survey of the KATM coast in 1981. An aerial survey to evaluate habitat within the park where peregrine falcons might occur, and to locate nests, was conducted in 1993 (White et al. 1993). One possible coastal nest was located during that survey. Occasional anecdotal sightings of peregrines have been recorded on sighting forms, primarily along the KATM coast. None of the KATM sighting records specify subspecies.

Bald eagle and golden eagle.—Nesting bald eagles are relatively common in KATM, primarily along the coast and along inland lakes and rivers. Aerial bald eagle surveys were conducted annually in the Park between 1974 and 1980 (Troyer 1974b, 1975b, 1976b, 1977c, 1978b, 1979, 1980c) and since 1983 similar surveys have been periodically carried out along specific inland lakes and streams where eagles are most likely to be subject to human disturbance (Jope and Starr 1983, Jope 1984b, Jope 1985b, Jope 1986b, Jope 1987, Sowl 1988, Squibb 1992, Savage 1993-1994, Savage 1997). In a few of these years, nests were also resurveyed for productivity. Extensive coastal bald eagle population and productivity surveys were conducted between 1989 and 1992 in response to the *Exxon Valdez* oil spill (Yurick 1989, Portner 1991). An adult bald eagle survey of the entire Alaska Peninsula was conducted by USFWS during late April 2000. The stratified random plot quadrat sampling included 3 sample plots along the KATM coast (Savage and Hodges 2000).

Golden eagles are occasionally observed in mountainous areas of KATM. An active golden eagle nest, and another inactive nest were documented in KATM in 1993 during an aerial survey to locate peregrine falcon nests (White et al. 1993).

Terrestrial Threatened and Endangered Species

Currently no federally listed species are known to occur in terrestrial areas of KATM. The USFWS formerly listed some wildlife species as category 2 candidate species, which indicated that further research was needed to assess biological vulnerability, taxonomy and/or threats. This designation was discontinued in 1996, and those species are now referred to by the USFWS as “species of concern.” Federal bird species of concern that occur in terrestrial areas of KATM include the harlequin duck, and olive-sided flycatcher. The American peregrine falcon was delisted in 1999, but will be listed by the USFWS as a species of concern for a monitoring period of five years.

American peregrine falcon, olive-sided flycatcher, gray-cheeked thrush, and blackpoll warbler are State of Alaska Species of Special Concern that have been documented or are thought to occur in KATM.

As indicated above, peregrine falcons have infrequently been sighted in KATM, and observations of nesting peregrine falcons are limited to a few along the coast. Harlequin ducks have been documented in anecdotal sighting records on several inland streams in KATM including Brooks River, Moraine Creek, and Funnel Creek (KATM unpubl. data, Olson et al.

2003). A single observation of an olive-sided flycatcher was recorded during a breeding bird survey of the VTTS road in 1994 (S. Savage, KATM, unpubl. data). Gray-cheeked thrush and blackpoll warbler have been recorded in all years in which breeding bird surveys were conducted along the VTTS road (S. Savage, KATM, unpubl. data).

Management/Human Use Issues

KATM recorded nearly 60,000 visitor days in 2002, and totals for 2001 and 2000 were 67,000 and 72,000, respectively. The Brooks River area is a primary center of human activity in KATM. In 2000 there were 9,880 visitor days recorded at Brooks River, and 9,650 were recorded in 2001. Although visitation occurs throughout KATM, it is typically focused in small areas such as the most accessible sections of fishing streams. The result is a pattern of intensive use of numerous widely dispersed areas. Given the relatively remote setting, some backcountry sites receive seasonally heavy human use.

Significant numbers of people fish on backcountry streams throughout KATM, and bear viewing has become an increasingly popular activity along some salmon streams. Bear viewing has also become popular along the Katmai coast, resulting in increasing seasonal concentrations of visitor activity in many of the coastal bays in which bears aggregate, particularly in early summer. KATM is accessed primarily by floatplanes. Boats are also used, particularly along the coast. In recent years, large 200-passenger capacity vessels have visited the KATM coast—Zodiacs are often used to carry passengers closer to shore to view wildlife, particularly bears. Jet boats are often used to transport people up shallow streams, and some anglers use rafts for transportation.

Existing developments in KATM include the infrastructure at Brooks Camp and Grosvenor Camp (a small concession lodge). Other existing lodges located on private land in the interior of the park include Kulik Lodge at the east end of Nonvianuk Lake, Enchanted Lake Lodge on a hill above the south shore of Nonvianuk Lake, and Battle Camp at the west end of Battle Lake. On the coast, Katmai Wilderness Lodge and Hallo Bay Wilderness Camp operate on private land.

Literature Cited

Alaska Department of Fish and Game (ADF&G). 2003. Region II briefing book, January 2003. Alaska Department of Fish and Game, Division of Wildlife Conservation, Juneau, Alaska, USA.

Bailey, E.P., and N. H. Faust. 1984. Distribution and abundance of marine birds breeding between Amber and Kamishak Bays, Alaska, with notes on interactions with bears. West. Birds 15:161-174.

Beattie, J.B. Brown bear/human interactions at Katmai National Park and Preserve: implications for planning and management. Senior thesis, University of California, Santa Cruz, California, USA.

Boyd, H.M. 1996. Bear management—1996. Resource Management Technical Report NPS/KATM/96-002. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Boyd, D.L. 1997. Bear management 1997. Resource Management Technical Report NPS/KATM/97-002. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Braaten, A.M. 1988. Adaptation of brown bears to people on an Alaskan salmon stream: a quantitative study. M.S thesis, Utah State University, Logan, Utah, USA.

Braaten, A.M., and B.K. Gilbert. 1987. Profile analysis of human-bear relationships in Katmai National Park and Preserve. Final report for NPS contract CX-9700-4-0019. Utah State University, Logan, Utah, USA.

Burke, T.A. 1992. Spring staging of waterfowl along the Naknek River, Alaska Peninsula, Alaska, April-May, 1991. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof National Wildlife Refuge Complex, King Salmon, Alaska, USA.

Carden, K.N., and B.A. McFarland. Brown bear management 1998, Brooks Camp, Katmai National Park. Resource Management Technical Report NPS/KATM/98-002.

Conant, B., J.I. Hodges, and D.J. Groves. 2000. Alaska-Yukon waterfowl breeding population survey, May 15 to June 10, 2000. U.S. Fish and Wildlife Service, Juneau, Alaska, USA.

Cook, N.A. 1992. Spring staging of waterfowl along the Naknek River, Alaska Peninsula, Alaska, February-May, 1992. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof National Wildlife Refuge Complex, King Salmon, Alaska, USA.

Dennis, C. R. 1973. Trapping for small mammals in Katmai National Monument, July 1973.

French, H.B., T. S. Smith, K.E. Kunkel, and E.H. Follman. 2001. Effects of human activities on activity budgets of brown bear (*Ursus arctos*) in the salt marsh at Hallo Bay, Katmai National Park and Preserve, Alaska. Poster presentation, Thirteenth International Conference on Bear Research and Management, Jackson Hole, Wyoming, USA.

Holmes, B. 1991. Summary of 1991 bear management incidents, Brooks Camp. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Holmes, B. 1992a. Hare surveys report 1989-1992, Valley of Ten Thousand Smokes Road. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Holmes, B. 1992b. Summary, bear management incidents, Brooks Camp, Katmai National Park, 1992. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Holmes, B. 1993. Summary: bear management incidents, Brooks River area, 1993. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Holmes, B. 1994a. Hare surveys progress report 1994, Valley of Ten Thousand Smokes Road. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Holmes, B. 1994b. Summary, bear management incidents, Brooks Camp, Katmai National Park, 1994. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Jope, K.L., and F.C. Starr. 1983. Nesting bald eagle survey, Katmai National Park and Preserve, 1983. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Jope, K.L., and L.B. Casebeer 1983. Brown bear population survey, Katmai National Park and Preserve, 1984. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-83/02. Anchorage, Alaska, USA.

Jope, K.L. 1984a. Brown bear population survey, Katmai National Park and Preserve, 1984. Katmai National Park and Preserve, King Salmon. Alaska, USA.

Jope, K.L.. 1984b. Nesting bald eagle survey, Katmai National Park and Preserve, 1984. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Jope, K.L. 1985a. Brown bear population survey, Katmai National Park and Preserve, 1985. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-85/05. Anchorage, Alaska, USA.

Jope, K.L.. 1985b. Nesting bald eagle survey, Katmai National Park and Preserve, 1985. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Jope, K.L. 1986a. Brown bear population survey, Katmai National Park and Preserve, 1986. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-86/08. Anchorage, Alaska, USA.

Jope, K.L.. 1986b. Nesting bald eagle survey, Katmai National Park and Preserve, 1986. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Jope, K.L.. 1987. Nesting bald eagle survey, Katmai National Park and Preserve, 1987. Katmai National Park and Preserve, King Salmon, Alaska, USA.

LaFrance, T., and J. Peterson. 1991. Backcountry report, Swikshak, 1991. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Litch, J.A., and B.A. Blackie. 1998 coastal seabird colony monitoring program. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Martin, C.J. 1989. Inventory of coastal seabirds in Katmai National Park and Preserve in 1989. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Mehall, A.C. 1993. Spring staging of waterfowl along the Naknek River, Alaska Peninsula, Alaska, March-May, 1993. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof National Wildlife Refuge Complex, King Salmon, Alaska, USA.

Miller, S.D., G.C. White,, R.A. Sellers, H.V. Reynolds, J.W. Schoen, K. Titus, V.G. Barnes Jr., R.B. Smith, R.R. Nelson, W.B. Ballard, and C.C. Schwartz. 1997. Brown and black bear density estimation in Alaska using radiotelemetry and replicated mark-resight techniques. Wildlife Monographs 133:1-55.

Moore, H. 1996. Spring staging of waterfowl along major drainages of Bristol Bay 1991-1995 with an emphasis on the Naknek River, Alaska, March-May, 1995. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof National Wildlife Refuge Complex, King Salmon, Alaska, USA.

National Oceanic and Atmospheric Administration (NOAA). 2003. Local climatological data annual summary (1971—2000). http://www.ncdc.noaa.gov/oa/climate/online/ccd/ (meantemp.html), (nrmlprecip.html), and (avgwind.html).

National Park Service (NPS). 1986. Katmai National Park and Preserve general management plan, wilderness suitability review, land protection plan. U.S. Department of the Interior, National Park Service, Denver Service Center, Denver, Colorado, USA.

Olson, T.L. 1993. Resource partitioning among brown bears at Brooks River in Katmai National Park and Preserve, Alaska. M.S. Thesis, Utah State University, Logan, Utah, USA.

Olson, T.L., and B.K. Gilbert. 1994. Variability in habitat use, movements, and activity of brown bears on an Alaskan river. International Conference on Bear Research and Management 9:97-106.

Olson, T.L., and R.C. Squibb. 1990. Brown bear behavior at Brooks River, 1990– final report. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Olson, T.L., and R.C. Squibb. 1991. Brown bear behavior at Brooks River, 1991– final report. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Olson, T.L., B.K. Gilbert, and S.F. Fitkin. 1990. Brown bear behavior and human activity at salmon streams in Katmai National Park, Alaska. Final report for National Park Service Contract IA 9700-7-8028. Utah State University, Logan, Utah, USA.

Olson, T.L., B.K. Gilbert, and R.C. Squibb. 1997a. The effects of increasing human activity on brown bear use of an Alaskan river. Biological Conservation 82:95-99.

Olson, T.L., M.T. Moran, and E.K. Bentley. Bear management at Brooks River, Katmai National Park, 2001. Resource Management Technical Report KATM-NR-02-02.

Olson, T.L., R.C. Squibb, and B.K. Gilbert. 1997b. A comparison of brown bear activity on salmon streams with and without people. Ursus 10:547-555.

Peirce, J., and T.D. DeBruyn. 1999a. 1999 brown bear monitoring, Brooks River area, Katmai National Park and Preserve. Resource Management Technical Report NPS/KATM/99-001. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Peirce, K.N., and T.D. DeBruyn. 1999b. A summary of bear/human interactions and recommendations for future management of the Brooks River Area, Katmai National Park and Preserve. Resource Management Technical Report NPS/KATM/99-002. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Platte, R.M., and W.I. Butler, Jr. 1995. Water bird abundance and distribution in the Bristol Bay Region, Alaska. U.S. Fish and Wildlife Service, Migratory Bird Management Project, Anchorage, Alaska, USA.

Portner, M. 1991. Bald eagle nest survey 1990—Katmai coast. U.S. Fish and Wildlife Service, Anchorage, Alaska, USA.

Proffitt, K.P. 2000. 2000 Brooks Camp bear management report. Resource Management Technical Report KATM-NR-02-01. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Ruhl, G., and H. Moore. 1996. Spring staging of waterfowl along major drainages of Bristol Bay with an emphasis on the Naknek River, Alaska, March-May, 1996. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof National Wildlife Refuge Complex, King Salmon, Alaska, USA.

Savage, S. 1993. Bald eagle nesting and productivity, Katmai National Park, 1992. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Savage, S. 1994. Bald eagle nesting and productivity, Katmai National Park, 1994. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Savage, S. 1997. Naknek drainage bald eagle productivity declines with spring rain. Presentation at the Seventh Alaska Bird Conference, Anchorage, Alaska, USA.

Savage, S., and J. Hodges. Bald eagle survey, Pacific coast of the Alaska Peninsula, Alaska, spring 2000. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof Wildlife Refuge Complex, King Salmon, Alaska, USA.

Scharf, L. 1993. Fall staging of waterfowl along the Naknek River, Alaska Peninsula, Alaska, August-November, 1993. U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof National Wildlife Refuge Complex, King Salmon, Alaska, USA.

Sellers, R.A. 1985. Preliminary report on 1985 moose composition surveys in Katmai National Park. Report prepared by Alaska Department of Fish and Game for Katmai National Park and Preserve, King Salmon, Alaska, USA.

Sellers, R.A. 1990a. Wolf survey-inventory report for regulatory years 1988-1989, game management units 9 and 10. Pages 33-36 *in* S.O. Morgan, ed.. Annual report on survey-inventory activities—wolf. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Program Report, Project 1-23-2, Study 14.0.

Sellers R. A. 1990b. Annual report of survey-inventory activities—moose. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Program Report W-23-2, Study 3.0.

Sellers, R.A., and S.D. Miller. 1999. Population dynamics of brown bears after the *Exxon Valdez* oil spill. Ursus 11:73-78.

Sellers, R.A., S.D. Miller, T.S. Smith, and R. Potts. 1999. Population dynamics and habitat partitioning of a naturally regulated brown bear population on the coast of Katmai National Park and Preserve. Resource Report NPS/AR/NRTR – 99/36. National Park Service, Alaska Support Office, Anchorage, Alaska, USA.

Smith, T.S., G.A. Wilker, and R.A. Sellers. 2001. The brown bears of Amalik Bay: movement patterns, home ranges, and terrain relationships of one of the densest bear populations in the world. Poster presentation at the Thirteenth International Conference on Bear Research and Management, Jackson Hole, Wyoming, USA.

Sowl, K. 1988. Bald eagle survey—1988. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Squibb, R.C. 1992. Nesting bald eagle survey, Katmai—1991. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Squibb, R.C., and B.R. Holmes. 1992. Analysis of bears involved in undesirable interactions with humans at Brooks River, Alaska. Poster presented at the Ninth International Conference on Bear Management and Research, Missoula, Montana, USA.

Starr, F., and P. Starr. 1992. Amalik Bay ranger station 1992, backcountry report. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Troyer, W. 1974a. Numbers, distribution, and composition of brown bears, Katmai area, Alaska. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-74/03. Anchorage, Alaska, USA.

Troyer, W. 1974b. Distribution and density of bald eagle nests, Katmai area, Alaska. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-74/02. Anchorage, Alaska, USA.

Troyer, W. 1975a. Moose census—Katmai National Monument, January-February 1975. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-75/02.

Troyer, W. 1975b.Distribution and density of bald eagle nests, Katmai area, Alaska. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-75/04. Anchorage, Alaska, USA.

Troyer, W. 1976a. Brown bear studies – Katmai: 1975. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-75/03. Anchorage, Alaska, USA.

Troyer, W. 1976b.Distribution and density of bald eagle nests, Katmai area, Alaska. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-76/03. Anchorage, Alaska, USA.

Troyer, W. 1977a. Brown bear studies – Katmai: 1976. Alaska Region, National Park Service. Anchorage, Alaska, USA.

Troyer, W. 1977b. Brown bear studies – Katmai: 1977. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-77/02. Anchorage, Alaska, USA.

Troyer, W. 1977c. Distribution and density of bald eagle nests, Katmai area, Alaska. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-77/01. Anchorage, Alaska, USA.

Troyer, W. 1978a. Brown bear studies – Katmai: 1978. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-78/02. Anchorage, Alaska, USA.

Troyer, W. 1978b. Distribution and density of bald eagle nests, Katmai area, Alaska. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-78/01. Anchorage, Alaska, USA.

Troyer, W. 1979. Distribution and density of bald eagle nests, Katmai area, Alaska. National Park Service, Alaska Region, Natural Resources Survey and Inventory Report AR-79/01. Anchorage, Alaska, USA.

Troyer, W. 1980a. Distribution and densities of brown bear on various stream in Katmai National Monument. Alaska Area Office, National Park Service. Anchorage, Alaska, USA.

Troyer, W. 1980b. Movements and dispersal of brown bear at Brooks River, Alaska. Alaska Area Office, National Park Service. Anchorage, Alaska, USA.

Troyer, W. 1980c. Memo to Area director summarizing bald eagle production survey of the Naknek Drainage. Alaska Area Office, National Park Service, Anchorage, Alaska, USA.

U.S. Fish and Wildlife Service (USFWS). 1991. A population estimate of tundra swans on western Alaska nesting habitat—1991, preliminary report. Migratory Bird Management, U.S. Fish and Wildlife Service, Juneau, Alaska, USA.

Warner, S.H. 1987. Patterns of brown bear and visitor use and recommendations for management. Katmai National Park and Preserve, King Salmon, Alaska, USA.

White, C.M., C. Johnsson, and P. Hardin. 1993. A peregrine falcon survey of Katmai National Park, Alaska. Final report for NPS Challenge Grant Account 5-20676. Brigham Young University, Provo, Utah, USA.

Wilk, R.J. 1988. Distribution, abundance, population structure, and productivity of tundra swans in Bristol Bay, Alaska. Arctic 41(4):288-292.

Yurick, M.M. 1989. 1989 raptor nest inventory and productivity survey. Katmai National Park and Preserve, King Salmon, Alaska, USA.

Kenai Fjords

Terrestrial Mammals

Twenty nine species of terrestrial mammals are documented or are expected to occur within Kenai Fjords National Park (AKNHP 2000 a). Among these, mountain goat (*Oreamus americanus*), moose (*Alces alces*), black bear (*Ursus americanus*), brown bear (*Ursus arctos*), hoary marmot (*Marmota caligata*), snowshoe hare (*Lepus americanus*), porcupine (*Erithizon dorsatum*), ermine (*Mustela erminea*), red squirrel (*Tamiasciurus hudsonicus*), and red-backed vole (*Clethrionmys rutilus*) are the species most frequently encountered (KEFJ 1999). Also present, but less frequently observed, are wolves (*Canis lupus*), coyotes (*Canis latrans*), lynx (*Felis lynx*), wolverine (*Gulo gulo*), marten (*Martes americana*), flying squirrel (*Glaucomys sabrinus*), beaver (*Castor candensis*), river otter (*Lutra canadensis*), little brown myotis bat (*Myotis lucifugus*), and mink (*Mustela vison*) (KEFJ 1999). The distribution, abundance, and breeding status of terrestrial mammal species in Kenai Fjords is, for the most part, unknown. Most information regarding terrestrial species in the park has come from anecdotal reports by park staff and visitors supported by a small number of surveys and research focused on bats and microtines (Wright 2001), mountain goats (Tetreau 1989), moose (Everitt 2001) and an ongoing survey of furbearer occurrence and distribution (Martin 2001).

Birds

218 species of birds are documented or expected to occur within Kenai Fjords National Park (AKNHP 2000 b). Most surveys and research on birds has focused on seabirds and shore nesting species (Bailey 1976, Nishimoto 1987, Tetreau 2002). A survey of the occurrence and distribution of bird species in the Exit Glacier study area was conducted in 2000 and 2001 (Wright 2001). Wright noted 199 individual observations representing 32 species and recorded the habitat type where each observation was made (Table 1).

Table 1: Population and species indices (from Wright 2001).

	Alder willow scrub	**Developing cotton wood**	**Mixed forests**	**Unvegetated**	**Conifer**	**Subalpine**
Total number of individuals	47	22	56	24	25*	25*
Population distribution	23.6%	11.0%	28.1%	12.1%	12.5%*	12.5%*
Total number of species	13	6	9	12	9*	9*
Approximate acreage of habitat	834	300	685	1,477	202	583**

*Conifer and subalpine habitats were surveyed in 2001 only.
**This acreage also includes alpine habitat.

The species most commonly observed by Wright (2001) were Wilson's warbler (*Wilsonia pusilla*), varied thrush (*Ixoreus naevius*), hermit thrush (*Catharus guttatus*), fox sparrow

(*Passerella iliaca*), ruby-crowned kinglet (*Regulus calendula*) and orange-crowned warbler (*Vermivora celata*). Other passerine (songbird) species commonly encountered include Steller's jay (*Cyanocitta stelleri*), black-billed magpie (*Pica hudsonia*), northwestern crow (*Corvus caurinus*), common raven (*Corvus corax*), chestnut-backed (*Poecile rufescens*) and black-capped chickadee (*Poecile atricapillus*), common redpoll (*Carduelis flammea*), snow bunting (*Plectrophenax nivalis*), white-winged cross bill (*Loxia leucoptera*), and dark-eyed junco (*Junco hyemalis*). Raptor species include bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), northern goshawk (*Accipiter gentilis*), sharp-shinned hawk (*Accipiter striatus*), and great horned owl (*Bubo virginianus*). Additionally, willow ptarmigan (*Lagopus lagopus*), rock ptarmigan (*Lagopus mutus*), white-tailed ptarmigan (*Lagopus leucurus*), and spruce grouse (*Falcipennis canadensis*) are present in upland areas of the park.

Amphibians

Wood frog (*Rana sylvatica*) and boreal toad (*Bufo boreas*) are both reported as occurring on the Kenai Peninsula (Hodge 1976), however neither species has been observed in Kenai Fjords National Park. An intensive survey for amphibians was conducted in the Exit Glacier area in 2001 and 2002 (Wright 2002). This survey resulted in no documented observations for either species.

Threatened and Endangered Species

No federally listed species are known to occur in terrestrial portions of the park. However, several State of Alaska Species of Special Concern and Alaska Audubon Society watch list species are present (Table 2). A State of Alaska Species of Special Concern is any species or subspecies of fish or wildlife or population native to Alaska that has entered a long-term decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance. Audubon's WatchList species are those facing population declines and/or threats such as habitat loss on their breeding and wintering grounds, or with limited geographic ranges.

Table 2. Terrestrial wildlife species of concern in the Exit Glacier Area.

Common name	**Species**	**State Listed[1]**	**Audubon Listed[2]**
Brown bear	*Ursus Arctos*	X	
Townsend's Warbler	*Dendroica townsendi*	X	
Gray-cheeked thrush	*Catharus minimus*	X	
Blackpoll warbler	*Dendroica striata*	X	X
Olive-sided flycatcher	*Contopus cooperi*	X	X
Golden Eagle	*Aquila chrysaetos*		X

1. Alaska Department of Fish and Game 2002.
2. Audubon 2002.

Townsend's warblers have been sighted in the Exit Glacier area during the breeding season and conifer habitat suitable for nesting is available throughout coastal areas of the park. Decreasing populations in Alaska for this species are thought to be due to habitat loss in neo-tropical wintering grounds.

Gray-cheeked thrush have been reported in the Exit Glacier area and along the coast during the breeding season and suitable woodland nesting habitat is available. Decreasing population

numbers for this species in Alaska are thought to be due to habitat loss in neo-tropical wintering grounds.

No observations of the blackpoll warbler have been recorded in KEFJ, however suitable closed spruce forest nesting habitat exists and the species is commonly observed in adjoining areas of the Kenai Peninsula. Loss of nesting habitat in Alaska due to recent widespread white spruce mortality from spruce bark beetle may be impacting this species in Alaska.

AKNHP (2000b) lists olive-sided flycatcher as expected to occur in the park. To date, however, no documented sightings of this species have been recorded in Kenai Fjords National Park. North American Breeding Bird Survey data provide strong evidence for population declines for this species over most of the breeding range. Because no consistent impact is immediately obvious across its broad breeding range, initial concern has focussed on problems on the winter range (Alaska Department of Fish and Game 2002).

Golden eagle are observed infrequently in the park, primarily in the early spring. No known golden eagle nesting sites have been identified in KEFJ. Populations of golden eagle have been observed to be in decline in some areas, however populations in Alaska appear to be stable.

Literature Cited

Alaska Department of Fish and Game. 2002. State of Alaska Species of Special Concern. **http://www.state.ak.us/local/akpages/FISH.GAME/adfghome.htm**.

AKNHP. 2000 a. Mammals of Kenai Fjords National Park and Preserve (KEFJ). Alaska Natural Heritage Program Report.

AKNHP. 2000 b. Birds of Kenai Fjords National Park and Preserve (KEFJ). Alaska Natural Heritage Program Report.

Bailey, E.P. 1976. Breeding seabird distribution and abundance along the south side of the Kenai Peninsula, Alaska. U.S. Fish and Wildlife Service. Unpublished Report.

Everitt, Christina. 2001. An evaluation of tourism impacts on six mammal species at Exit Glacier, Kenai Fjords National Park. University of Greenwich. Masters Thesis.

Haeusser, P.J. and G. Plafker.. 1995. Earthquakes in Alaska. (http://quake.wr.usgs.gov/prepare/alaska/). USGS Open file report 95-624. 1 map.

Hamilton, T.D. and S. W. Nelson. 1989. Introduction to Guide to the Geology of the Resurrection Bay-Eastern Kenai Fjords Area. Alaska Geological Society, Anchorage, Alaska.

Hodge, R.P. 1976. Amphibians and reptiles of Alaska, the Yukon and Northwest Territories. Alaska Northwest Publishing Co., Anchorage.

Karlstrom, T.N.V. 1964. Quaternary Geology of the Kenai Lowland and Glacial History of the Cook Inlet Region, Alaska. USGS. Wash D.C. 1964. 69 pgs, 7 plates.

KEFJ. 1999. Resource Management Plan. Resource Management Division, Kenai Fjords National Park, Seward, Alaska.

KEFJ. 2002. Wildlife Observation Database. Resource Management Division, Kenai Fjords National Park, Seward, Alaska.

Martin, Ian. 2001. Exit glacier area mesocarnivore survey study plan. Resource Management Division, Kenai Fjords National Park, Seward, Alaska. Unpublished report.

Martin, Ian. 2002. Personnel Communication. Resource Management Division, Kenai Fjords National Park, Seward, Alaska.

National Audubon Society. 2002. Audubon WatchList 2002: An Early Warning System for Bird Conservation. National Audubon Society, Inc. New York, NY. http://www.audubon.org/bird/watchlist/index.html

Nishimoto, M and Rice B. 1987. A resurvey of seabirds and marine mammals along the Kenai Peninsula, Alaska during the summer of 1986. U.S. Fish and Wqildlife Service and National Park Service. Unpublished Report.

NPS. 1999. Weather Observation Data Set 1990-1998, Aialik and Nuka Bays, Kenai Fjords National Park. Digital files.

Rice, W.D. 1987. Changes in the Harding Icefield, Kenai Peninsula. Alaska. MS Prof Paper, Univ of Alaska.

Rice, W.D. and P. Spencer. 1990. Tree cores of sitka spruce along the temporal sequence of Northwestern Glacier. Unpublished data collected in 1990.

Spencer, P. 2002. Ecological profile of the Kenai Fjords National Park coastlands. National Park Service Southwest Alaska Inventory and Monitoring Network. Unpublished Report.

Tande, G.F. and J. Michaelson. 2001. Ecological Subsections of Kenai Fjords National Park, Alaska. The Alaska Natural Heritge Program, University of Alaska, Anchorag, Alaska. 19 pts + digital data files.

Tetreau, Mike. 1989. Mountain goat activity budgets for primary activities from October 1988 to February 1989. Kenai Fjords National Park. Unpublished data.

Wright, Ami. 2001. Final Report: 2001 Field Season. Resource Management Division, Kenai Fjords National Park, Seward, Alaska.

Wright, Ami. 2002. Amphibian Survey Final Report. Resource Management Division, Kenai Fjords National Park, Seward, Alaska.

York, G. and A. Milner. 1999. Colonization and Community Deveopment of Salmonoids and Benthic Macroinvertebrates in a New Steam Within Keani Fjords National Park, Alaska. Final Report the NPS, Coop Agreement no CA 9700-2-9021. ENRI, University of Alaska. Anchorage, Alaska.

Lake Clark

Terrestrial Mammals

Thirty-six species of terrestrial mammals are documented or expected to occur within Lake Clark National Park and Preserve. Periodic efforts to monitor moose (*Alces alces*) and Dall sheep (*Ovis dalli*) populations have occurred since the early 1980's.

Moose- Moose trend surveys were conducted in 3 areas between 1984 and 1992. Stratified random sampling (Gasaway et al. 1986) yielding density and population estimates in 3 survey units were initiated in 1992. Each unit was to be surveyed on a 3 year rotational schedule, but due to factors such as poor survey conditions this goal has not been meet. Population estimates for the survey unit south of Lake Clark were 241.3 ± 70.0 in 1992 and 229.1 ± 37.4 in 1998. bull:cow ratios decreased from 73.3 in 1992 to 36.7 in 1998. Cow:calf ratios were 12.5 and 8.3 in 1992 and 1998, respectively. Population estimates for the 2 survey units north of Lake Clark were 342.5 ± 70.9 and 596.6 ± 61.8 in 1994 and 1999, respectively. Funding was obtained to conduct a moose sightability study using radiocollared animals and will be completed in 2003. A sightability model will be developed and used to obtain more reliable moose survey data. A project to determine moose seasonal ranges, adult survival, and calf productivity and survival in areas where subsistence harvest is concentrated was conducted from 1996-2000. Results of this study along with population surveys indicate low calf production and/or survival. A 3 year moose forage availability and use study will begin in 2003.

Dall sheep- Dall sheep (*Ovis dalli*) reach the southern extent of their range in LACL and occur along the western slopes of the Chigmit Mountains on the common boundary of the park and preserve. Eight Dall sheep aerial surveys have been conducted between 1978-1995. Complete surveys, encompassing 6 units, were conducted in 1981 and 1987 resulting in a total count of 805 and 1088 sheep, respectively. Stratified random sampling of subunits within the 6 survey units resulted in population estimates of 520 and 716 sheep in 1992 and 1995. Ewe:lamb ratios declined from 58.0 and 76.6 during the 1981 and 1987 surveys to estimates of 37.5 and 31.8 in 1992 and 1995. New Dall sheep projects will begin in 2003. Aerial surveys will be conducted in survey units 1 and 2 in response to proposals from the Lake Clark Subsistence Resource Commission to liberalize subsistence sheep harvest regulations. Aerial surveys and intensive monitoring of a sheep mineral lick will be conducted in the Twin Lakes area of the park.

Caribou- The Mulchatna Caribou Herd (MCH) calves adjacent to the western boundary of the preserve and ranges through the foothill lakes and tundra plains of the western preserve. This herd is one of the most important for local subsistence and non-local resident hunters and heavily supports Alaska's guide and transporter industry. Recent Alaska Department of Fish and Game (ADF&G) data suggests the herd is slowly declining from a high of over 200,000 to its current estimated size of 147,000. Bull:cow ratios are declining as well. In response, ADF&G is formalizing an interagency MCH technical working group which will convene it's first meeting in April 2003. The group will review herd biological status reports, the objectives of agencies' programs, plan and coordinate future biological assessment work, and brainstorm future research programs.

Bears- Brown/grizzly bears (*Ursus arctos*), common in all habitats, are most numerous along the coast, where an estimated 180-230 bears graze in salt marshes during the summer (Bennett 1996). An intensive and systematic effort was made to collect data on brown bear use of coastal salt marshes in Tuxedni Bay during 2001 and in Chinitna Bay during 2001-02. Data are currently being analyzed. Monitoring at Tuxedni Bay revealed numerous low level aircraft passes over bears and several boat trips, presumably related to bear viewing tourist activities. Bear viewing is well established at Chinitna Bay. Since 1996, a guide service located on private land adjacent to bear foraging areas has offered overnight lodging and day trips. Other guiding services are considering purchases of nearby private inholdings for the purpose of offering bear viewing opportunities to clients. Efforts to derive black and brown bear density and

population estimates over large areas of the park and preserve are being conducted in cooperation with ADF&G. A significant portion of Game Management Unit (GMU) 9B, centered on Lake Clark was surveyed using an aerial line transect double count technique in 1999 and 2000. Preliminary analysis indicates a density of 40.9 brown bears per thousand square kilometers. This aerial census technique will be used to determine bear density and population parameters in GMU 9A, which includes the park's coastal habitat, in 2003. Black bears (*Ursus americanus*) use all areas of the park and preserve except the higher elevations. Data for black bears is not yet available from the GMU 9B survey.

Other mammals- Wolves (*Canis lupus*), lynx (*Felis lynx*), coyotes (*Canis latrans*), and wolverines (*Gulo gulo*) range widely throughout the forests and low alpine areas, also populated with porcupines (*Erethizon dorsatum*) and snowshoe hares (*Lepus americanus*). Hoary marmots (Marmota caligata), arctic ground squirrels (*Spermophilus parryii*) and pikas (*Ochotona collaris*) occur in alpine meadows and boulder fields. Twelve species of vole, lemming and shrew probably occur, of which the redback vole (*Clethrionomys rutilus*) is most abundant. Mink (*Mustela vison*), beaver (*Castor canadensis*) and river otter (*Lontra canadensis*) inhabit ponds, lakes and rivers. River otters are particularly common along the coast. Red squirrel (*Tamiasciurus hudsonicus*), American marten (*Martes americana*), shorttail weasel (*Mustela erminea*) and least weasel (*Mustela nivalis*) are also found throughout the park and preserve. Little is known about the abundance and distribution of these species in LACL.

Birds

189 species of birds are documented or expected to occur in the park and preserve. Of these, 70 are land birds, and many are neotropical migrants. Raptors, including bald eagle (*Haliaeetus leucocephalus*), golden eagle (*Aquila chrysaetos*), northern goshawk (*Accipiter gentilis*), sharp-shinned hawk (*Accipiter striatus*), northern harrier (*Circus cyaneus*) , and merlin (*Falco columbarius*), breed in the area. About 50 pairs of bald eagles and 5-10 pairs of golden eagles are known to nest in the park and preserve. Two pairs of osprey (*Pandion haliaetus*) also nest in the preserve. Bald eagle nest occupancy and productivity has been monitored yearly throughout the park and preserve since 1992. Peregrine falcons (*Falco peregrinus*) occupy eyries on cliffs along interior lakes and rivers, and at Tuxedni Bay. Peregrine falcon eyries and breeding activity were observed at 6 sites along the park coastline from 1994-96 (Bennett 1996).

Little is know regarding abundance and distribution of other land birds, including neotropical migrants, in Lake Clark National Park and Preserve. The breeding biology of the montane nesting surfbird (*Aphriza virgata*) was studied in a 100 km² area centered at Turquois Lake from 1997-98 (Gill et. al. 1999). Data on nesting wandering tattlers (*Heteroscelus incanus*) as well as opportunistic sightings of birds and mammals was also obtained during this study.

Waterfowl nest and molt in wetlands throughout the area. Large migratory flocks of ducks, swans, and geese rest and feed in the park and preserve before flying from Nikabuna Lakes to Lake Clark through low mountain passes in the Chulitna River drainage. Bennett (1996) determined migratory waterfowl numbers and distribution, and productivity of local breeding species, trumpeter swans (*Cygnus buccinator*) and common loons (*Gavia immer*) along the coast from 1994-1996. Sea ducks, primarily White-winged *scoters (Melanitta fusca*) and surf scoters (*M. perspicillata*), are the most abundant waterfowl on the coast, numbering over 18,000 in mid-August. The coast also provides important breeding habitat for mallards (*Anas platyrhynchos*), American widgeon (*Anas americana*), Barrow's golden-eye (*Bucephala clangula*), and red-throated loons (*Gavia stellata*). Migrating dabbling ducks number 3,000-4,000 in spring and fall. Diving ducks, primarily Greater (*Aythya marila*) and lesser scaup (*A. affinis*), stage along the coast in spring. They reach peak abundance (16,400 birds) in mid-May.

Other ducks include green-winged teal (*Anas crecca*), northern pintail (*A. acuta*), harlequin (*Histrionicus histrionicus*), common golden-eye *(B. islandica*), black scoter (*M. nigra*), common eider (*Somateria mollissima*), bufflehead (*Bucephala albeola*), and oldsquaw (*Clangula hyemalis*). About 30 pairs of trumpeter swans (*Cygnus buccinator*) nest in the park and preserve; most breed in wetlands on the coast. Canada geese occur in Tuxedni Bay and can number about 4,400 during fall migration.

Seabird breeding colonies occur along Cook Inlet, and concentrate at Tuxedni and Chinitna bays (Bennett 1996). Of the seven seabird colonies surveyed from 1994 to 1996, the largest contained 2,700 black-legged kittiwakes (*Rissa tridactyla*). Less numerous seabirds include horned puffins (*Fratercula corniculata*), double-crested cormorants (*Phalacroconax auritus*) , pelagic cormorants (*P. pelagicus*), glaucous-winged gulls (*Larus glaucescens*), tufted puffins (*F. cirrhata*), common murres (*Uria aalge*), and pigeon guillemots (*Cepphus columba*). During spring migration, 86,000 to 122,000 shorebirds, primarily Western sandpipers (*Calidris mauri*) and dunlin (*C. alpina*), use intertidal mud flats in Tuxedni and Chinitna Bays.

Amphibians

The wood frog, the lone species of amphibian found in the region, inhabits the margins of lakes and ponds of the western foothills and the shores of Cook Inlet.

Threatened and Endangered Species

Currently no federally listed species are known to occur in terrestrial areas of LACL. Federal species of concern (formerly category 2 candidate species) that occur in terrestrial areas of LACL include the harlequin duck, olive-sided flycatcher (*Contopus cooperi*), and lynx. The American peregrine falcon was delisted in 1999, but will be listed by the USFWS as a species of concern.

American peregrine falcon, olive-sided flycatcher, gray-cheeked thrush (*Catharus minimus*), Townsend's warbler (*Dendroica townsendii*), and blackpoll warbler (*D. striata*) are State of Alaska Species of Special Concern that have been documented or are expected to occur in LACL.

Management/Human Use Issues

Residential subdivision and economic development on private lands is a major threat facing natural resources within the park and preserve. About 617,000 acres are in private or state ownership, or are being adjudicated. This includes approximately 75% of the shoreline of Lake Clark and more than 90% of the park coastline in Cook Inlet. Small tract ownership has resulted in the development of hunting and fishing lodges, airstrips, small roads, and ATV trails. Large tracts conveyed to state or Native regional corporations are subject to resource extraction activities. Cook Inlet Region, Incorporated (CIRI) is investigating joint venture partners to develop a mine near the Johnson River headwaters and is exploring the feasibility of access routes from the mine site to Cook Inlet. The state has selected almost 22,800 acres of land (subsurface mineral rights only) along the eastern boundary of the park, and if conveyed will be subject to mineral exploration and extraction, most likely by state lease to private individuals and corporations. Cominco has filed state minimg claims north of Lake Iliamna about 15 miles southwest of the preserve boundary. If developed, this open pit mine would be the largest in Alaska. Other resource extraction activities include current timber harvest on Native association lands within the Crescent River watershed which drains into Cook Inlet. Oil and gas development occurs in lower Cook Inlet. Previous state sales excluded tracts within three miles

of Lake Clark National Park and Preserve. If oil and gas resources were discovered beyond the three-mile limit, the potential would exist for onshore petroleum facilities on the west side of Cook Inlet. Tuxedni Bay has been identified as a possible onshore treatment site if a petroleum reserve is found.

Another area of concern for resource managers is subsistence and sport harvest of mammals, fish, and birds within and on land adjacent to parks and preserves. ANILCA (Alaska National Interest Lands Conservation Act) allows subsistence harvest of fish, wildlife, wood, and plants in the park, and sport hunting and trapping in the preserve. Sport hunters primarily seek caribou, moose, and brown bear. Subsistence users hunt, fish, trap, cut firewood and house logs, and harvest plants and berries in both the park and preserve. Important subsistence resources include caribou, moose, ptarmigan, spruce grouse, porcupine, beaver, black bear, and ducks. Wildlife viewing activities, particularly bear viewing in coastal habitats, has increased.

Literature Cited

Bennett, A.B. 1996. Physical and Biological Resource Inventory of the Lake Clark National Park-Cook Inlet Coastline, 1994-96. Lake Clark National Park and Preserve, Port Alsworth, AK. 137pp.

Gasaway, W.C., S.D. DuBois, D.J. Reed, and S.J. Harbo. 1986. Estimating moose population parameters from aerial surveys. Biol. Papers of the Univ. Ak. No. 22, Fairbanks, 108 pp.

Gill, R.E., P.S. Tomkovich, and M.N. Dementiev. 1999. Breeding ecology of Surfbirds (Aphriza virgata) at Turquoise Lake, Alaska, 1997-98. Unpubl. Rept., U.S. Geological Survey, Alaska Biological Science Center, Anchorage, AK. 39pp.

9. Invited Participants, Fauna Monitoring Scoping Workshop

Bennett, Alan, Coordinator
Southwest Alaska Network
National Park Service
2525 Gambell St
Anchorage, AK 99503
907/257-2628
alan_bennett@nps.gov

Burch, John
Wildlife Biologist
Yukon-Charley Rivers Preserve
201 1st Ave Doyon Building
Fairbanks, AK 99701
907/455-0623
john_burch@nps.gov

Debruyn, Terry
Wildlife Biologist
National Park Service
2525 Gambell St
Anchorage, AK 99503
907/257-2564
terry_debruyn@nps.gov

Duffy, David
Conservation Biologist
University of Hawaii at Manoa, Botany Department, 3190 Maile Way, St. John #408 Honolulu, HI 96822
Ph: (808) 956-8218
Fax: (808) 956-3923

Gill, Bob
Research Wildlife Biologist
Alaska Science Center
USGS-BRD
1011 East Tudor Rd
Anchorage, AK
907/786-3514
robert-gill@usgs.gov

Golden, Howard
Division of Wildlife Conservation
Alaska Department of Fish and Game
333 Raspberry Road
Anchorage, Alaska 99518
(907) 267-2177
howard_golden@fishgame.state.ak.us

Hamon, Troy
Chief of Resources Mgmt
Katmai/Aniakchak/Alagnak
King Salmon, AK 99613
907/246-2121
troy_hamon@nps.gov

Knuckles, Penny
Chief of Resources Management
Lake Clark National Park and Preserve
Port Alsworth, AK 99653
907/781-2113
penny_knuckles@nps.gov

Mortenson, Dorothy
Data Manager
Southwest Alaska Network
2525 Gambell St
Anchorage, AK 99503
907/257-2626
dorothy_mortenson@nps.gov

Oakley, Karen
Consultant to NPS-Alaska Vital Signs Monitoring Program
Alaska Science Center
USGS-BRD
1011 East Tudor Rd
Anchorage, AK 99503
907/786-3579
karen_oakley@usgs.gov

Leacock, William
Biological Inventory Coordinator
Southwest Alaska Network
National Park Service
2525 Gambell St
Anchorage, AK 99503
907/257-5428
william_ leacock@nps.gov

Martin, Ian
Wildlife Biologist
Kenai Fjords National Park
Seward, AK 99664
907/224-2146
ian_martin@nps.gov

McBurney, Mary
Subsistence Coordinator
Lake Clark/Katmai
National Park Service
2525 Gambell St
Anchorage, AK 99503
907/257-2633
mary_mcburney@nps.gov

Olson, Tammy
Wildlife Biologist
Katmai/Aniakchak/Alagnak
King Salmon, AK 99613
907/246-2104
tammy_olson@nps.gov

Putera, Judy
Wildlife Biologist
Lake Clark National Park and Preserve
Port Alsworth, AK 99653
907/781-2107
judy_putera@nps.gov

Spencer, Page
Ecologist
NPS-Alaska Support Office
2525 Gambell St
Anchorage, AK 99503
907/257-2625
page_spencer@nps.gov

Troutman, Jeff
Chief of Resources Management
Kenai Fjords National Park
Seward, AK 99664
907/224-2111
jeff_troutman@nps.gov

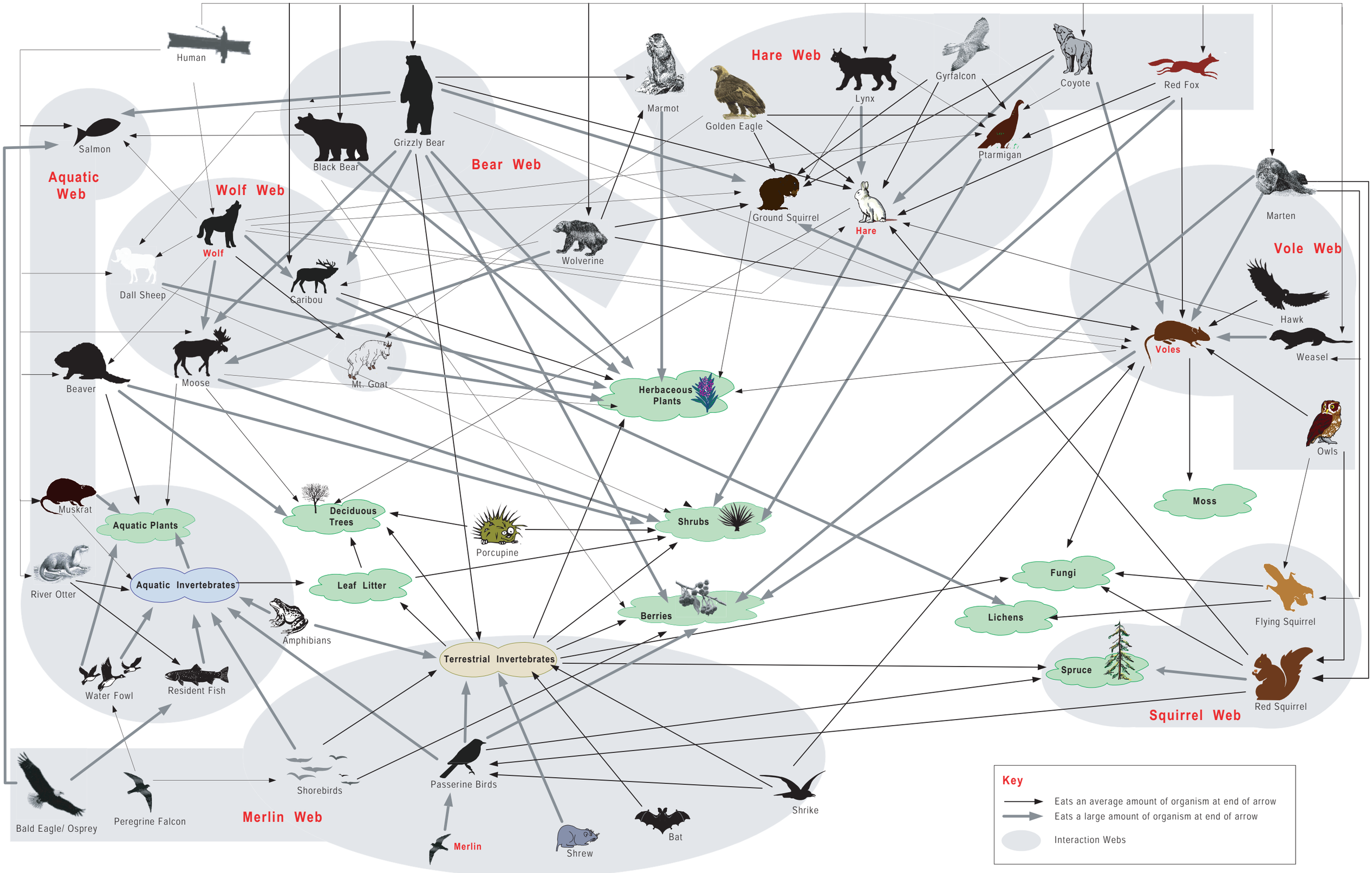
Wesser, Sara
Regional I&M Coordinator
National Park Service
2525 Gambell St
Anchorage, AK 99503
907/257-2557
sara_wesser@nps.gov

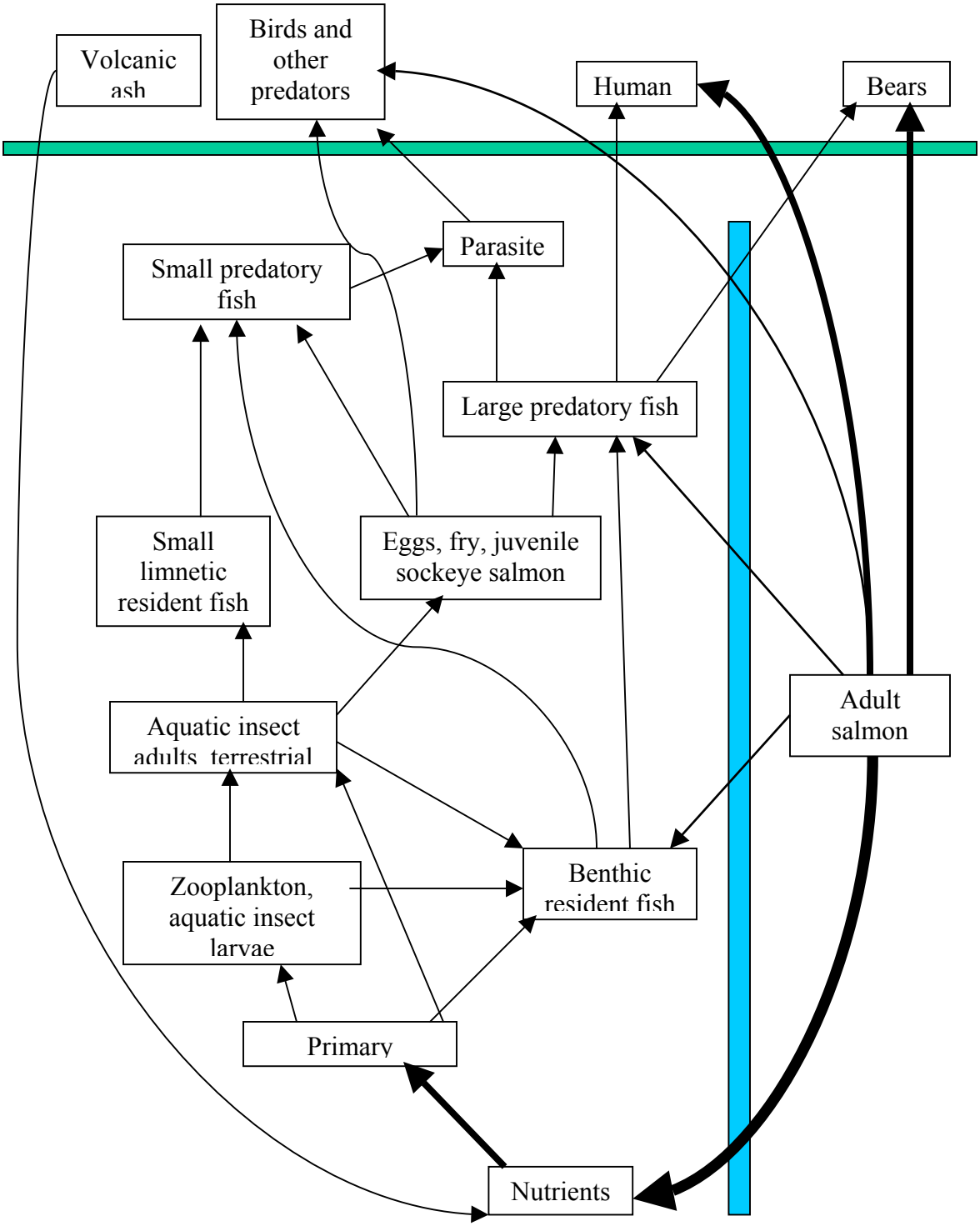
Woodward, Andrea
USGS FRESC Olympic Field Station
c/o WFRC
6505 NE 65th Street
Seattle, WA 98115
206/526-6282 ext. 332
andrea_woodward@usgs.gov

Guest attendees from outside the Southwest Network Parks are highlighted

SWAN Landscape - Who Eats What?

Modified from: Karen Oakley an d Susan Boudreau, Conceptual Design of LTEM for Denali, 2000.



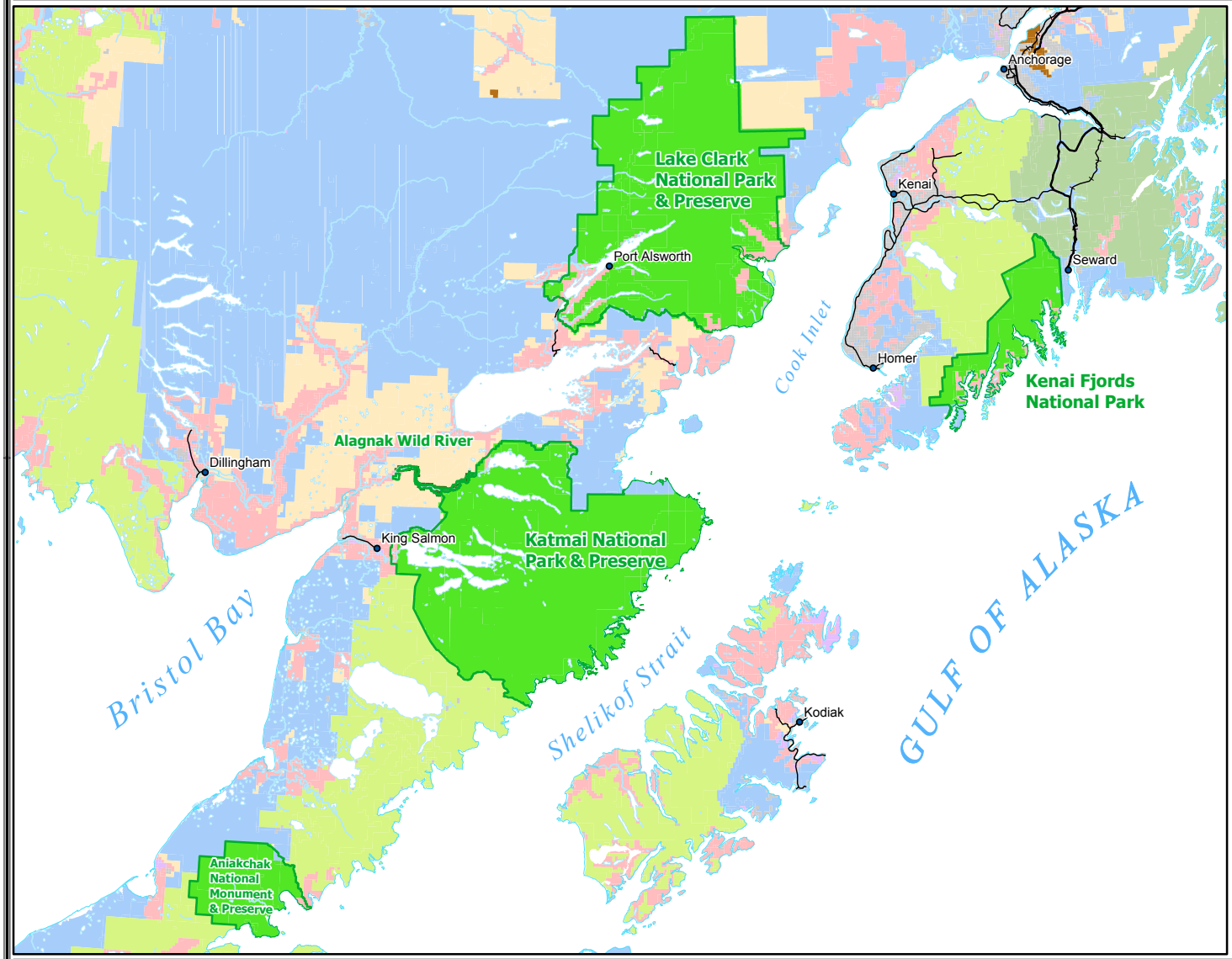


The influx of anadromous fishes dramatically affects the trophic structure of freshwater and terrestrial ecosystems. Most salmon die after they spawn and their carcasses accumulate in streams and along lakeshores. A rich community of algae, fungi, and bacteria develops on the carcasses and populations of invertebrates increase. These invertebrates then serve as food for fish in the streams and lakes, including juvenile salmon. More surprising are the potential fertilizer effects of salmon carcasses on land. Bears and other carnivores commonly haul salmon, living or dead, onto stream banks and hundreds of yards into the forest. Eagles move carcasses into riparian areas and ravens and crows cache salmon bits in trees and under grass and rocks. Nutrients pass from the bodies of salmon into the soil and then into riparian vegetation and ultimately farther up the terrestrial food chain.

General Land Ownership

Southwest Alaska Network Inventory & Monitoring Program

Alaska Region
National Park Service
U. S. Department of the Interior



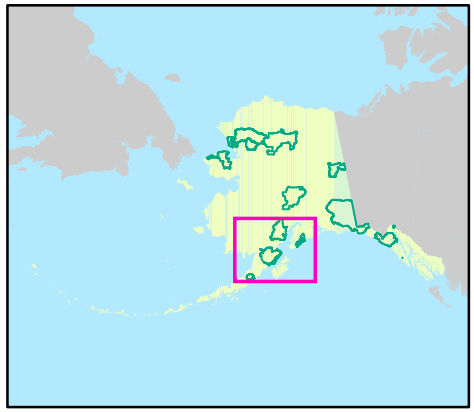
LEGEND

General Land Ownership

- National Park Service
- Wild & Scenic Rivers
- US Fish & Wildlife
- US Forest Service
- Bureau of Land Management
- Native
- State
- Native/State
- Major Military
- Other Private

Source: Generalized land ownership provided by the Alaska Department of Natural Resources, 2001.

0 10 20 40 60 80 100 Miles

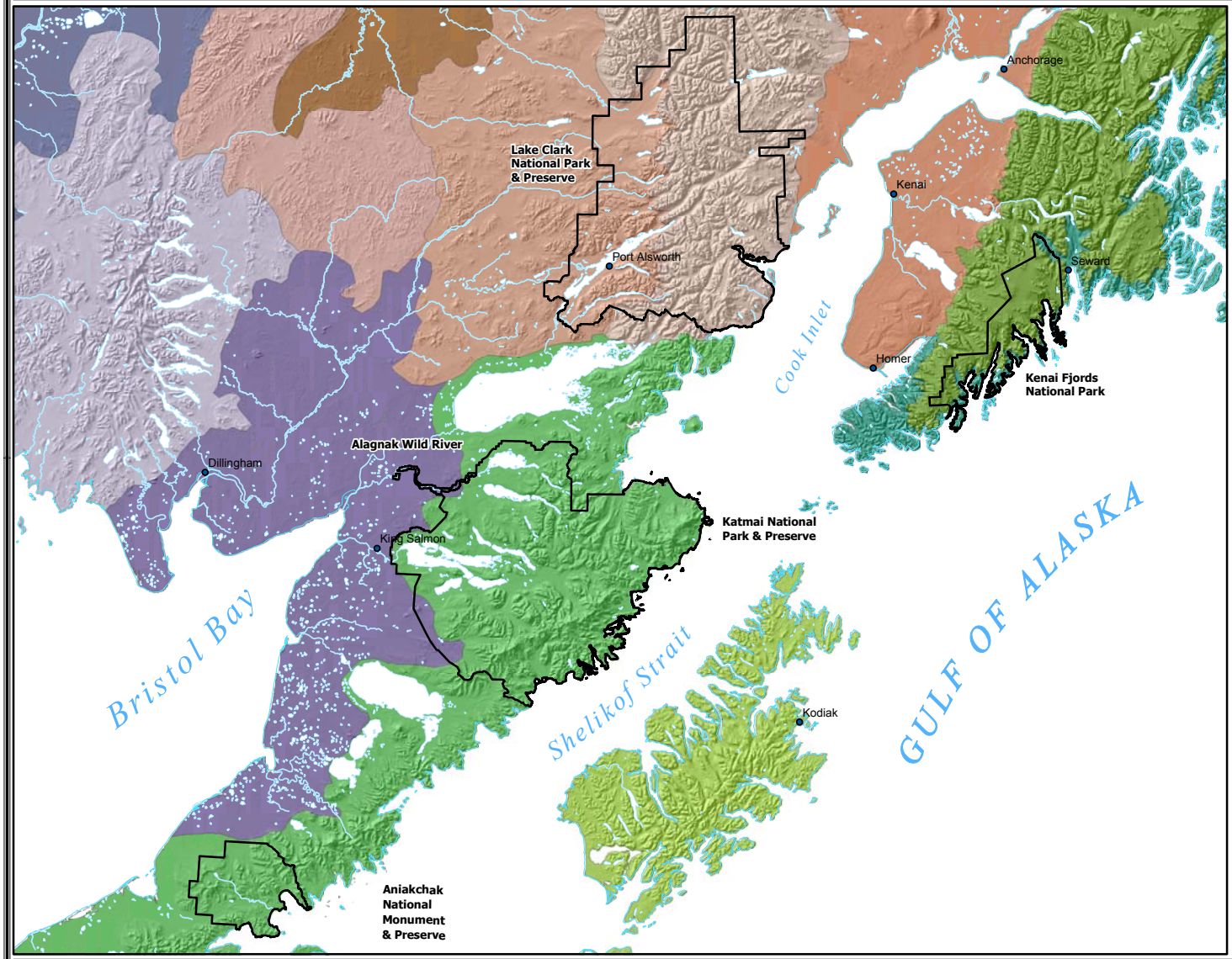


SWAN Landownership D. Mortenson 7/11/2002

Ecoregions

Southwest Alaska Network Inventory & Monitoring Program

Alaska Region
National Park Service
U. S. Department of the Interior

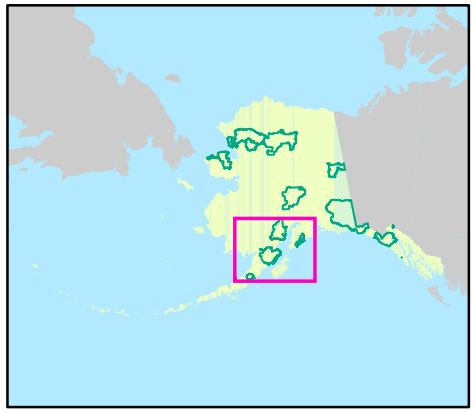


LEGEND

- 8) Yukon-Kuskokwim Delta
- 9) Ahklun Mountains
- 10) Bristol Bay Lowlands
- 11) Kuskokwim Mountains
- 15) Tanana-Kuskokwim Lowlands
- 20) Lime Hills
- 21) Cook Inlet Basin
- 22) Alaska Range
- 27) Alaska Peninsula
- 28) Kodiak Island
- 29) Gulf of Alaska Coast
- 30) Chugach-St. Elias Mountains

Source: Ecoregions of Alaska and Neighboring Territory.
National Park Service, 2001.

0 10 20 40 60 80 100 Miles



SWAN Ecoregions D. Mortenson 7/19/2002